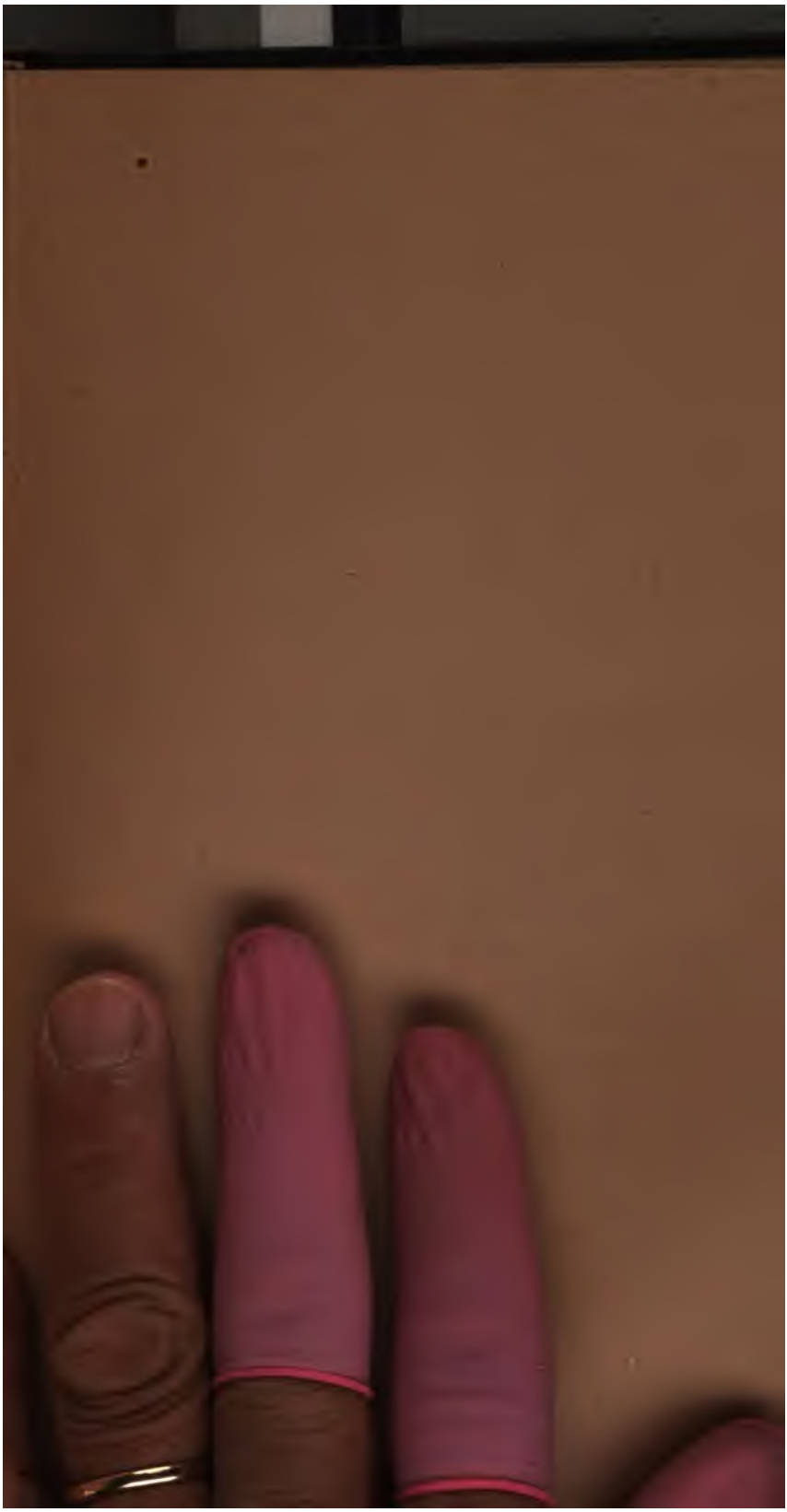

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METHODICAL TREATISE

ON THE

ultivation of the Mulberry Tree,

ON THE

RAISING OF SILK WORMS,

AND ON

WINDING THE SILK FROM THE COCOONS.

Inited to an accurate description of the Winding Mill. With Plates.
Abridged from the French of M. De la Brousse: with
Notes and an Appendix.

BY WILLIAM H. VERNON,
Of Rhode-Island.

Si palma [illegible] compressa est labor

BOSTON:
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TO THE

CULTIVATORS OF THE SOIL

IN THE

UNITED STATES,

WITH A DEEP SENSE OF THE VALUE OF THE SERVICES

WHICH THEY ARE

CONSTANTLY RENDERING TO THEIR COUNTRY,

AND THE

HIGHEST CONSIDERATION FOR THEIR

DOMESTIC VIRTUES, THIS WORK IS WITH PROFOUND

RESPECT INSCRIBED

BY THEIR FELLOW CITIZEN,

WILLIAM H. VERNON.

PREFACE.

In books of mere amusement, many persons are so desirous to be entertained, and to commence their acquaintance with the personages of the story, that they pass over the preface unnoticed, though it may contain information which would give additional zest to their entertainment. But in works upon subjects of public utility there is no such apology, nothing so attractive for the reader, and the introductory discourse gains a perusal from the expectation of finding something necessary to a proper conception of their contents. It becomes then a part of my duty to give a preliminary account of the volume here respectfully presented to the public.

The first part comprises a well digested treatise on the cultivation of the mulberry tree, in which the original author enters into a variety of practical details on its production and treatment. But the utility of his precepts is not confined to that particular species of tree. They are most of them equally applicable to nearly all the different kinds of fruit-trees, and our enlightened cultivators would derive much benefit from the adoption of a similar system of management for their orchards. His prescriptions on sowing, planting, watering, tilling, grafting, laying and pruning, are all of them excellent, and, though not wholly unknown here, are generally unused or neglected by our farmers. The rules which he enforces are the result of long observation and successful practice, and prove that in agriculture, as well as in every other art, profit can be derived only from labour and science.

In the second part, the author treats scientifically of the silkworm, from its birth to the chrysalis; of the supply and of the

preservation of the seed for the next year's brood; and of that essential point in the production of good silk, the winding of the fibres from the cocoons. Those who have intended, or may hereafter propose to themselves, to undertake this business, ought not to be discouraged by the numerous obstacles detailed by my author, or by the various cares so emphatically required by him for a successful raising of the worms; nor ought they to be deterred from the enterprise by the extreme difficulty of drawing a well nourished and glossy silk from the cocoons, which may vie in beauty with that of the Piedmontese. The labour and attention demanded for the worms are of short duration; and winding-mills, constructed with mathematical precision, will enable us to acquire that perfection in the use of them which experience and long practice alone can give.

For the more perfect illustration of this work, and to make it more worthy of public acceptance, four plates, with the necessary letters of reference, have been engraved by a skilful artist.

Though M. De la Brousse judiciously adopted a methodical arrangement by dividing his treatise into books and chapters; yet being more of a practical man than an able writer, he frequently anticipated his matter, and in the first part of his publication introduced silk-worms and scattered them among his trees. It became, therefore, necessary to correct this improper distribution, to collect his misplaced materials, and to carry them forward to their proper station in the chapters of the second book. All his discursive reflections upon general agriculture, and many of his endless repetitions, I have taken the liberty to suppress, though I have retained a few of these last, for the sake of impressing some leading precept more strongly upon the mind of the unpractised. But notwithstanding these blemishes, M. De la Brousse has produced a very useful book, and one which entitles his name to be mentioned with respect.

BOOK THE FIRST.

Before we speak of raising Silk-worms, which is the principal object of this treatise, we ought to make known the different species of the mulberry-tree, and point out those which are the most proper for the nourishment of the Silk-worm. After giving the regular process, which a long experience has taught us to be the most successful in providing the only salutary food for Silk-worms, we will endeavour to exhibit, circumstantially, the best manner of raising these worms, of selecting the cocoons, and of winding off the Silk.

CHAPTER I.

ON THE MULBERRY TREE IN GENERAL AND OF ITS DIFFERENT KINDS.

This useful tree was brought to us from China, and has since spread all over Europe.* The lands

* I am not prepared to contest this assertion, as it may relate to the white mulberry so appropriate to the silk-worm. But I well remember to have seen it stated in the course of my reading, that the mulberry tree is indigenous in various parts of

of Italy and Spain were the first to receive it. In France, we owe to Henry the IV. one of the best of our kings, the propagation of the mulberry-tree, patronised by his Letters Patent of the 21st of July, 1602. We are also indebted to Louis the XV. for the increased quantity of mulberry-trees in this kingdom, by the encouragement which he gave to cultivators in 1766.* This tree, protected in our days by several of the governments of Europe, merits a particular attention, since it has become as useful as it is lucrative. The worm which gives us silk, takes no other nourishment than the leaf of the mulberry tree. One can give it no other vegetable without impairing its health and risking its life.

There are two species of mulberry-trees; the white and the black. The white mulberry puts forth light green leaves, smaller and thinner than those of the black mulberry. They are besides longer than they are broad, and the green of the under side of the leaf differs from that of the up-

Europe, and if I mistake not, even in France. It is not an exotick in our own country, and Miller mentions the large leafed Virginia sort, with red fruit, which grows spontaneously in the woods of North America. Yet the white is with us also of foreign origin.

* In commencing this abbreviation, I have not suppressed these two periods of the first paragraph of this chapter, though at the first glance they may appear of no importance to the American reader. But they strongly establish the durable bene-

per side, only by being less glossy. The leaves of the black mulberry are wider than they are long; they are thick and covered underneath with a sort of white down. The white mulberry grows fast and produces shoots long and slender. The black mulberry gives shoots thicker and shorter, and it vegetates more slowly. The barks as well as the fruits of the two sorts of trees are very different. The white mulberry has a yellow bark, and its fruit is white and insipid; but the black is clothed with a bark of a much darker hue, and gives excellent mulberries, which we eat with pleasure, and which are regarded as a salutary fruit.

There are four kinds of the white mulberry; the wild mulberry, the grafted mulberry, the rose mulberry and the Spanish mulberry. The wild mulberry is generally produced from the seed of the grafted mulberry; its leaves are small, thin, indented, and of a deep yellowish green. The grafted mulberry tree produces a beautiful, well spread leaf, and of peculiar excellence for silk-

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fits which a country derives from a provident government, and they hold up to the people and to the legislature of this Union one powerful evidence more, that the introduction of a new branch of national industry requires some stimulating or fostering act, if not the pecuniary aid of the Administration. The result of the above policy is already a tribute of more than 500,000,000 dollars, in the agregate, from foreigners, and a much larger saving to the French nation.

worms in the last stages of their growth. The rose coloured mulberry is nearly as good, but its leaves are thinner and of a more beautiful green than those of the ingrafted mulberry. The Spanish mulberry gives a wide thick leaf, full of juice, and bears a grey coloured fruit much larger than that which is known here by the name of the grafted mulberry. Under the denominations, then, of black and white mulberry, we find five sorts; four of which, the wild, the grafted, the rose and the Spanish, belong to the white species; and the black stands alone. The leaves of all these may serve for the nourishment of silk-worms; but it is not a matter of indifference to make use of one, or of the other sort. On the contrary, the success of raising silk-worms, the quantity of silk which they give, as well as its intrinsic beauty, depend much upon the choice of their food.

The black mulberry is the least advantageous for silk-worms, because it produces a coarse silk, and for this reason it is not used as a food for them. The Spanish mulberry would have the same effect if the silk-worms were nourished a long while with its thick and fat leaf. But those who are skilled in the care of silk-worms, do not touch this leaf before the moment of the greatest consumption, and at the time when they need to be filled with substantial nourishment.

The leaf of the wild mulberry being very small

and very thin, it nourishes little when it is gathered upon meagre or sandy land. It would be necessary to have a large plantation of this sort of tree in order to secure a good income to the cultivator; but if these mulberry trees were planted in a rich soil, the result would be different.* We lose our silk-worms, in the low Languedoc, only through the want of this sort of wild mulberry upon our good lands; although it be absolutely necessary to have grafted mulberry trees upon our bad lands. That neglect, and the great heats which we sometimes experience in the month of May, both in Provence and Languedoc, are the two causes of the failure of the crops of silk, which are otherwise so lucrative.

The leaf of the grafted white mulberry is preferable to all others for the nourishment of silk-worms. Its leaf is more tender, and the worms

* The proprietors of the soil in the two former provinces of southern France, which, before the modern division into departments, were so well known by the names of Provence and Languedoc, cultivate the white mulberry as an object of revenue. None of the rich, and perhaps few of the middling classes of land-holders undertake to raise silk-worms. This care is generally confined to the small proprietors and to the peasantry, whose agricultural labours are commonly bestowed upon articles of subsistence, and they purchase the mulberry leaves from those land-holders who can conveniently appropriate a part of their estates to the cultivation of the white mulberry. From the leaves of this tree, which sell from five to six livres the quintal, they derive a good income.

eat it more greedily. This early mulberry puts forth its leaves fifteen days sooner than the black and the Spanish mulberry. It grows faster; adapts itself to all sorts of soils, and its leaves augment the quantity and improve the quality of the silk.

Every thing is useful in the mulberry tree. Its first leaves are valuable in the silk which they produce by nourishing the silk-worm; its second leaves fatten our cattle; its fruit is excellent for poultry and for sheep, and the wood is useful for joiners and makes good fuel. The mulberry tree may also serve as an ornament to our gardens. Very different from the hornbeam which never attains a good height; from the elm which is often devoured by caterpillars; from the ash which makes no shade, the mulberry tree joins to its pecuniary benefits every other advantage that you may desire. It makes a refreshing shade; it covers itself with a magnificent foliage, it grows to the height that you may wish; it takes any form that you please to give it, and as this tree is always handsome and useful, the Author of nature has been pleased to add cleanness, for we rarely if ever see upon it caterpillars, lizards, spiders or any other sort of vermin.

CHAPTER II.

OF THE CHOICE OF SOIL FOR A NURSERY OF MULBERRY TREES, AND OF THE MANNER OF SOWING THE MULBERRIES.

A soil mild, light and mixed with much mould, is the most proper soil for a nursery of mulberry trees. New shoots must have ground easy to penetrate. Strong, clayey land does not suit these new plants, unless, by mixing with it a great quantity of sheeps' dung and sand, it be made light and friable. Thus prepared by this manure, and by three dressings with the hoe, or by ploughing it three times, and afterwards levelling the ground, it will be fit to receive the seeds of the mulberry.

Upon two acres of land, or any other quantity, at the will of the proprietor, beds must be made four feet wide, levelled and smoothed with the rake. On these beds must be traced by a line, eight small furrows lengthwise, two inches wide and very little more than half an inch deep, and at the distance of six inches from one furrow to another.

At the moment of establishing this nursery, it is necessary to be provided with mulberries from

the white wild mulberry tree, or else from the Spanish mulberry tree, which are the two most proper kinds for this purpose; they must then be dropped in the furrows, at the distance of twelve inches from each other, must be covered from the sides of the furrows, and the beds carefully levelled off with a short toothed rake.

There are two seasons for making nurseries; the spring, and the time of the maturity of the fruit. Those who choose to sow the seed of the mulberry in the month of April, must consequently use the dried seed, gathered nine months before, and less apt to sprout. But those who sow the grain at its maturity, enveloped with all the moisture of the fruit which seems intended for its nourishment and to give it, if we may use the expression, its first milk, have generally the pleasure of seeing it put forth with vigour. Besides, the heat of the season, provided the proprietor have the attention to water the plants, will necessarily cause their rapid growth.

CHAPTER III.

OF THE MANNER OF MULTIPLYING MULBERRY TREES BY CUTTINGS.

The soil chosen to receive the slips of the mulberry tree ought to be prepared in the same manner with that selected for sowing the seed, and which we described in the preceding chapter. The cuttings of the mulberry tree are to be planted as we plant the cuttings of the vine; that is by making furrows by a line at the distance of six feet from one to the other, and by crossing them by furrows at the same distance in order to form squares. A two year old branch of a mulberry tree, having wood of four or five years at one end, must be selected, and the extremity of the old wood must be interred to the depth of about ten inches, The branches, chosen from the white or from the rose mulberry, must be taken off in the spring at the time of the first rising of the sap. Two or three incisions must be made in the joints or knots of the old wood; because this operation will facilitate the shooting of the roots, which always put forth from the joints of the old wood.

The cuttings must then be covered with a well manured and friable earth, and the end of the branch which rises from the soil must be cut off at the third bud from the surface. If rains should not frequently occur after the plantation is finished, it would be necessary to water the plants often. The multiplication of mulberry trees by means of cuttings has the important advantage of a produce of two years in advance over the establishment of a nursery by the means of seed.

CHAPTER IV.

OF THE MANNER OF MULTIPLYING MULBERRY TREES BY LAYERS.

To make layers is to force a branch or a shoot of a tree or of a shrub to become itself a tree or a shrub, by putting a branch or a shoot into the ground without separating it from the parent tree. The spring and the autumn are both suitable seasons for this operation. There is no precise time for making layers in autumn. Every day of that abundant season is at the service of the

cultivator; he has only to choose those that suit him best. In the spring he is more restrained, for he must wait till the frosts are passed, and till the mulberry be in full sap.

The shoots which arise at the foot of a tree; the young and smooth branches found about the lower part of the mulberry; any other branches that are long and supple enough to be secured in the ground; and lastly the shoots of a young tree whose trunk is not high, and which may be layed as easily as the young shoots of the vine; all these offer abundant resources to the man who has the industry to use them. We will now give the manner of performing each of these operations.

1st. If there arise some vigorous shoots at the foot of a mulberry tree, a hole must be dug six or eight inches deep, near each shoot, into which the shoot must be laid, without twisting it, or separating it from the tree. It is then to be secured in its place with crotchets of wood, and covered with good mould, which must be pressed over it, and the end of the shoot which rises above the ground must be cut off above the second bud. It will be further necessary to place, by the side of the layer, a stake to mark the place and prevent its being trodden. It must likewise be watered immediately after the operation, and as often

afterwards as may be necessary to maintain about it a proper state of moisture.

2d. The young and smooth twigs among the branches of the mulberry, may be passed through a basket or a vase perforated at the bottom, and filled with earth well manured. The twig must be cut off four or five inches above the vase or the basket, and the mould must be kept in a due state of moisture by frequent waterings.

3d. When a mulberry tree is well spread, and the boughs nearest the ground have not been lopped, some of the branches, at the distance of six feet from each other, may be bent down and secured in the ground, so that the ends shall not rise more than six or eight inches above the surface. The same attention as to staking, manuring and watering must be pursued for the complete success of this method as well as for all the others. This manner of making layers is perhaps the easiest and most profitable, because the success of a branch may yield several trees, and it proves at the same time the infinite resources and power of vegetation.

4th. If we have any young, grafted mulberry trees. whose trunks are not high, with four or five smooth and vigorous branches, we may open as many trenches, nearly as long as the branches, and eight or ten inches in breadth and depth. The roots of the little tree are cut off on the side

opposite to the trenches; the earth is taken from about the trunk, and the tree inclined towards the openings in order to secure, with less risk of fracture, each branch in its proper place. The trenches are then filled and watered as in the preceding cases. The ends of the twigs are brought about six or eight inches above ground, and a prop is placed near them for their support, and to prevent their being broken under foot.

The young mulberry tree, from which we have made these layers, must be weakened by this procedure; it would droop and perhaps perish if we did not repair its losses. This tree, deprived of half of its roots, is nevertheless forced to nourish all the layers. It is therefore necessary to give to the roots which remain, that increase of strength to be derived from manure and water.

All the layers made in these four different ways may be separated from the parent tree in the autumn of the second year. We prefer the autumnal transplantation, provided it do not freeze, to that of the spring. Is it reasonable to expect that a tree should perform two such opposite functions at the same time, as the settling itself by the roots immediately after removal, and the putting forth new shoots? This is however the operation which we require of the spring transplantation, and which is the real cause of the feeble vegetation that attends the first season after the removal.

But the autumnal planting offers a more favorable result; because the roots not only become firmly fixed in their position, but put forth before the severe frosts, numerous small fibres, which powerfully contribute to the flow of the sap in the following spring, as it generally appears by the abundance and the vigor of the new wood. Pulpy trees, with a large pith, such as the Madeira walnut or the fig, whose bark when young is so apt to be affected by rigid cold, and even by white frosts, are perhaps the only sorts of trees that ought preferably to be planted in the spring.

After ascertaining that the layers have taken root, they must be cut off four inches from the parent trunk; be taken up carefully with their roots and small fibres, and placed in the nursery, or permanently established in an orchard. In the nursery they must be set at the distance of six feet from each other; and in the following year, by heading them down, four or five layers may be made from each. By these means, one hundred trees may be increased, in four years, to eighteen hundred; for the parent trees, after the layers are separated from them, being replaced in a straight position, secured to a prop, manured and watered, generally retrieve their strength and make productive trees.

If the young layers be planted in an orchard, the same care must be taken of them as when set

in a nursery. Trees in the early stages of their expansion, like the growth of young animals, require an abundant nourishment. Four tillages each year with the hoe or the plough; frequent waterings if the season should be dry; manure worked into the ground in October; all this is scarcely sufficient for a new plantation. We must besides, two or three times in the course of the summer, take up the weeds which grow near them, and throw them at the foot of each tree. We consider these weeds useful not only as a manure, but as a hindrance to the lodgment of insects which dislike the mephitical air arising from vegetables in a state of decomposition.

When the layers are separated and carefully taken from the parent tree, if they be placed in a nursery, they must be set as we have before said, at the distance of six feet from each other; but if in an orchard, they must be placed in quincunx order thirty feet apart.

CHAPTER V.

OF THE DWARF OR BUSH MULBERRY.

The dwarf, or bush mulberry, has been cultivated for ages in the East Indies. It is there preferred to the tree with a high trunk, because its leaves are more easily gathered, the trimming less difficult and less expensive, and the sap, having a shorter distance to rise into the branches, produces earlier leaves, and proportionably in greater abundance. The leaves of the dwarf mulberry being more abundant in the first years of the tree than in those of trees of high stem, consequently give an earlier income to the proprietor; but these last, in their turn, at mature age, produce a greater quantity of leaves. The tree with a lofty trunk must have a good soil and ample room, whilst the dwarf trees will grow any where, upon an arid soil, and a small space; extending their branches very little, they may be reached on all sides; yielding an early leaf, and full as wholesome for the silk-worm as that of the high tree.

The grafted dwarf mulberry of good kinds, such as the rose, putting forth as early as the *pourette*,

is of great resource in a warm climate, where silk-worms succeed only when they are raised in the early part of the season.

The field selected for a plantation of the dwarf mulberry ought to be ploughed, and after remaining in the furrow a month or two, to be manured and cross-ploughed, and then levelled off with a harrow. Lines must then be drawn nine feet apart the whole length of the field, and the young trees must be planted in these lines, at the distance of six feet from each other. These mulberry trees, more especially when planted in a meagre soil, must be attended to in the same manner as those of a lofty growth. Frequent tillage, manure every year, and watering in a dry season, are all indispensable, particularly in the first years of their vegetation. If it should be found that a light plough cannot be used without disturbing the roots, the hoe must be applied about these trees. Besides, it would be difficult to employ the plough among trees whose stems are so short, and which send forth their branches within a foot of the soil. An axiom in rural economy, that the greater the disbursement in improving the land, the greater the proportional rent, is a truth realized every day by those who have the good sense and the industry to practise upon it.

The dwarf mulberry ought not to be trimmed till after gathering the leaves in the third year. Then

it will be necessary to leave four branches at proper distances towards each of the cardinal points, in order that they may form, in the three succeeding years, the head of the tree. At the end of that term, each tree will nearly touch its neighbour, and ought, every following year, to be pruned immediately after the gathering of the leaves. This trimming with us consists in lopping off the branches which have yielded leaves during three years, and reserving the wood of the preceding and of the current years. The height of the trunk of a dwarf mulberry being regulated at a foot, and its branches spreading, in the second year, about two feet and a half in all directions, they would be within the reach of the smallest cattle, and would soon be destroyed by them. All kinds of cattle ought, therefore, to be most carefully excluded.

CHAPTER VI.

OF THE MANNER OF PLANTING MULBERRY TREES OF HIGH GROWTH.

These mulberry trees succeed best upon a good friable soil, in which there is a proportionable

mixture of sand; because their roots do not incline to dip, but extend almost horizontally to a great distance. They are less exposed to the blasting effects of a white frost in the spring, when they are placed at a proper distance from ponds and rivers, and planted rather upon the eastern, southern or western declivities of hills, sheltered from the northern blasts. The young mulberry selected for planting, ought to be of the middling size; its bark of a yellowish brown, slightly rough by the exfoliations of its surface, but without crevices; and it must moreover be furnished with three or four rather slender than large roots. It ought not to be more than three years old when taken from a rich soil; or four years old if removed from poor land.

In a plantation on a good soil, some of the rows of trees ought to be seedlings and not grafted, because the leaves of this kind of tree are there improved, but are still less succulent than those of the grafted tree, and therefore afford a more proper nourishment to the silk-worm in its first ages; for this worm often becomes diseased, and perishes through excess of food.

The trees procured for planting ought to be from six to nine feet in height, and about six inches in circumference at the lower part of the trunk. The holes for their reception must be made eighteen inches deep, and from five to six

feet in diameter. The bottoms of these holes must be covered with a few inches of fresh mould; and after those roots that are bruised or broken are lopped just above the defect, the young tree is placed in its proper range, ascertained by a stake at each extremity of the line, and it is held there till its roots are covered with a foot of friable and well manured earth, free from stones, which must then be well trodden down. But in order to give immediate activity to the sap, as well as to make the earth on all sides closely adhere to the roots, six or eight gallons of water ought to be poured into the hole, which may then be filled with earth to the surface. A small cavity, however, must be left around the stem of each tree for the purpose of retaining the rain, and the waterings which it may be found necessary to give them.

It would be desirable to ascertain the exposition that the plant had in the nursery, which may be easily discovered by the magnitude and the number of its roots, which are generally more considerable on the south side of the tree, as well as by the size and the distance of the rings or circles which form at the forks of the branches. Directed by these signs, one may give to the tree the same exposition which it had before its removal, by attentively turning to the south the largest roots and circles.

When the trees shall have nearly attained their growth, two dressings a year will be sufficient to maintain them in good condition. The first may be given in the month of March, or the time of the first rising of the sap, when, after hoeing, they ought to receive a due quantity of manure. The second tillage must be given immediately after gathering the leaves, in order to promote the August growth, upon which the produce of the following year so much depends.

The mulberry planted upon light or meagre lands, as well as young trees newly set upon a good soil, require four dressings yearly. The first in February; the second in April; the third after the gathering of the leaves, and the fourth in August. *There is a freshness and a strength communicated to the tree and to its roots by this attentive tillage, and the benefit is so visible, that even an unpractised eye will at once distinguish the plantation of the industrious from the negligent proprietor.*

It is almost an unpardonable sin to sow or plant a piece of land covered with the mulberry of high growth; but it would be an act still more inexcusable to sow with grain, or any other produce, an orchard of these useful trees newly set. Though the ground be not wholly covered, and but partially shaded by these small trees, yet any grain, roots, or grass would exhaust the soil, retard the

activity of the sap, and obstruct the expansion of every part of the tree. *Nemo duobus*, is a maxim so true in agriculture, that every proprietor who has attempted to take at the same time two full crops from the same land, has unwisely exhausted the soil, and finally diminished his income. By manuring well our fields, and requiring but one crop at a time, we shall make better harvests, and receive a better rent.*

If the trees which we plant have not already been grafted, they may be budded in the month of August following their plantation, or grafted in the succeeding Spring.

Every thing that is young requires continual cares. These attentions must extend to every ob-

* The whole of this paragraph ought peculiarly to attract the notice of the farmers of our own country; for it is of general usage with them to take a crop of grain, of roots, or of grass from their orchards. This custom, so inconsistent with sound reason, added to their careless treatment of their trees, is the cause of that infertility of which we hear them so often complain; and it also very materially affects the quality of the fruit. At Montreuil, a village of nearly twenty thousand inhabitants, all maintained by the cultivation of fruit for the supply of the city of Paris, a proprietor will not allow even a plant of lettuce to be grown near his fruit trees. Every particle of the surface of the ground is there kept in a friable state to the full extent of the roots of the tree; a due proportion of manure is every year worked into the soil; the art of trimming is there perfectly understood and as perfectly practised; and there we never hear the barbarous assertion that the apple tree bears well only once in two or three years.

ject of which we wish to promote the existence on the surface of the earth. Children, young animals, vegetables newly sown or planted, all need a daily and a vigilant fosterage. It is then our interest to attend diligently to our young trees; to visit them often in the first year of their growth; to rub off the buds, or lop the shoots which put forth on the stem below the head of the tree; to preserve only four of the largest shoots, and the most properly distributed to form the head. In the following spring, at the time of the first rising of the sap, those four branches may be reduced to three, which will be sufficient to make a well formed head. When this is done, the knife must not for some time be again applied to these young trees, unless it be to lop off the suckers that may arise between or about those chosen branches. It would however, be requisite to cut off the dead wood which is sometimes found in the spring at the ends of the branches, and at the forks of the tree. If this should be neglected, the rot might afterwards gain the trunk.

In order to reap some profit every year from these young trees, the cultivator ought to cleanse them annually, by cutting off all the branches which have put forth and are badly disposed on the crown of the tree, and by lopping the dry wood, and the suckers which arise perpendicularly from the body or from the branches, as well as the long and slim

shoots with buds small and far apart. Suckers are also long, with buds slender and distant, but they are of quick and stout growth, and as straight as a pickstaff. They are called suckers because they draw the sap from the branch which nourishes them, and in a few years would cause it to perish. During the first four years, all these attentions are necessary, but after that space of time, they may be treated in the same manner, and be trimmed at the same intervals with the old trees. In our eighth chapter this important operation of trimming shall be discussed and explained so fully as to enable the man heretofore the most uninformed, to use or to direct hereafter the saw and the knife with some benefit to his trees.

CHAPTER VII.

OF GRAFTING AND OF BUDDING MULBERRY TREES.

Grafting and budding produce in the mulberry an effect similar to that which they cause in fruit trees; they improve the sap, and make it put forth a larger and a more nourishing leaf. When silk-worms are fed with the leaves of the graft-

ed white mulberry, especially in the last stage of their existence as worms, that is, after the fourth change of the skin, the silk which they yield is finer and more abundant.

The different methods of split-grafting, of tongue grafting, and of flute-grafting, are so well known, that we think it is not requisite to give here a particular description of these operations. We shall merely remark that it is essential to adapt the bark of the scion, particularly at its upper extremity, to the bark of the stock, and to place the scion on the north or on the east side, in order that it should be less exposed to be withered and dried by the heat of the sun.

Budding may be performed with us, in Languedoc and Provence, in April, June, July, and August. That of April succeeds only when done within the first eight or ten days of the rising of the sap. But the last days of June, and the whole of July and August, are favourable times for the insertion of buds. We must here again urge the necessary attention of closely uniting the upper part of the bark containing the bud, to the bark of the transversal incision of the stock, otherwise the union will fail. Another important observation in budding is, to be sure that the germ of the bud adhere to the bark which is taken off. The bud is defective if there remain upon the branch from which it is taken a small point or elevation, imme-

diately above the place which the bud occupied; or a cavity in the under side of the bark directly under the eye. These two facts corresponding, the bud must be rejected, and we must try another. Here also, as in the case of grafting, the buds ought to have a northern or an eastern exposure, in order that there should be less risk of desiccation.

When we bud the mulberry in April, in the latter end of May, and in July, it is essential to take off a ring of bark from the budded branch, at about three inches above the place of insertion. By this process the inserted eye receives all the sap which rises, and puts forth a handsome branch in the same season; which has given to this method the appellation of the shooting bud.

In the month of August, on the contrary, we simply lop the ends of the branches of the stock, after having budded them, and leave them in that state till the following spring. By this management the graft receives as much nourishment as is necessary to incorporate it with the stock, but does not put forth in the same year; therefore this manner is called the sleeping bud. In the ensuing spring, however, when the sap begins to be in activity, a ring of bark must likewise be taken off above the inoculation, and its effect will soon be seen by the swell of the eye, and by the vigour and speed of the shoot. If a ring had been form-

ed at the time of the late budding in August, it would have sent forth a frail twig, which the winter's frosts would have destroyed. But the operations of the spring, of the latter part of May, and those of June and July, may be forwarded in that manner, because the wood which they make has time to mature, and to acquire strength and compactness sufficient to resist the variations of an inclement winter.

There is always some risk in grafting and budding mulberry trees, and complete success is only the result of very heedful attention. The mulberry and the fig, abounding in sap, are of so tender a nature, that a simple incision, or a slight bruise, often becomes a sort of ulcer, which spreads rapidly, and which, if neglected, requires years to heal. If a bud happen to fail, we are surprised to find in the ensuing year, a large wound at the place of incision, which sometimes embraces half the circumference of the stock, and which, if disregarded, would cause its death.*

Another method of grafting, which we are now about to explain, is extremely advantageous, since by a single graft we make two trees, and by one operation the proprietor doubles the result of his labour. Another strong inducement for practising it, is the simplicity and easiness of the operation.

* The reader will find in my note at the close of the next chapter, a remedy as well as a preventive, for both these evils.

But it succeeds only with trees of two or three years old.

A handsome and well nourished branch is taken from the best kind of white mulberry, as nearly as possible, of the size of the young wilding which we are about to graft. It is then reduced to the length of twelve or fourteen inches, and pointed to the depth of six inches at the foot of the subject; and near enough to be easily united together. A cut is then made about two inches long with a sharp knife, to the centre of the wilding, and the piece is taken out; a corresponding cut of the same dimensions and depth is made in the branch that is to serve as the graft; the two channels are then joined together, so that the bark of the subject and that of the branch shall coincide at least on one of the sides, for the connexion between them must begin at the bark. When they are thus adjusted, they must be secured in their position by the winding of yarn, or of narrow woollen bandages about them the whole length of the cuts, which are then overlaid with mastich of clay and cow-dung, as in ordinary grafts. The inventor of this method says that the graft may be left at its whole length, and the subject be suffered to remain in its natural state. But we think that the operation will more readily succeed by cutting off the summit of the graft, and leaving only two or three good eyes above the

bandage. We are also of the opinion, that the callus would sooner and more surely form, if a ring of bark about half an inch wide were taken from the subject three or four inches above the point of junction.

When the operation is finished, the wild stock must be abundantly watered, and the waterings must be repeated from time to time during a month or six weeks, in order that the moisture of the earth should furnish nourishment to the branch till it be incorporated with the stock. At the expiration of six weeks, the bandage may be taken off, and the head of the wild stock must be lopped above the graft, in order that the planted branch may receive all the sap. But the lower part of the branch must remain in the ground till the following year; and, as by its union with the wild stock it draws from thence its nourishment, it will not fail to take root. In the ensuing spring it must be cut off below the graft, and it then forms another mulberry tree, which may be taken up and placed at will.

This grafting operation is generally done in the spring, at the time when split-grafting is performed, that is, when the sap begins to be well in motion, and before the buds develope. If one had mulberry trees of two or three years old, that were in boxes or in pots, one might graft them in this way even in the midst of winter, by observing to keep

them in a place sufficiently temperate to maintain the circulation of the sap.

It would be well to cast a shovel-full of consumed manure at the foot of each wild stock that we graft in this manner; for the more nourishment the earth yields, the more certain the success, especially with regard to the branch that serves as a graft, which will more readily put forth roots in a manured and fertile soil than in arid, meagre land.

This method of propagation has several advantages which do not belong to any other. 1st. It may be practised throughout almost all the seasons of the year. 2d. One may graft branches large enough to make trees that will very soon become productive. 3d. The proprietor doubles his plantation by producing two trees at one operation.

We admit that this manner of grafting has one inconveniency: it is that the branch which takes root is apt to degenerate, and to become a sort of wild stock. What confirms us in this opinion is, that in planting a fruit tree, if it should be set deep enough to cause it to put forth roots above the graft, it degenerates, and yields a more indifferent kind of fruit. There is, however, a remedy to this evil in the mulberry, as well as in all other fruit trees. In order to restore to them the quality of grafted trees, it is sufficient to make with the grafting knife a circular incision through the bark

of the trunk, a little above the soil. This must be done in the spring season, when the strong flow of the sap will soon unite the lips of the incision, and form a callus, which will produce the effect of the graft, because the sap, in its ascent to the branches, must pass through this tumour, and there improves and acquires the qualities which it has in grafted trees. Moreover, if it should be thought that there be some risk in cutting off all the tubes of circulation at once, although our experience has not proved that there is any, the operation may be executed in two different times. The first incision, then, may be made to embrace one half the circumference of the trunk, in order that the circulation may continue through the undivided tubes of the other half; and at the conclusion of three or four weeks, when it shall be perceived that the callus is formed, the second incision must be made in the remaining half, taking care to unite it, by the two extremities, to the first, so that no tube in the whole circumference shall be without its callus.

The attentions which grafts of all kinds afterwards require for the preservation of their shoots, are nothing more than an amusement. They must be visited fifteen or twenty days after the operation, for the purpose of lopping the wild twigs that may have put forth about the scion. The whole of them, however, must be retrenched only when

these shoots and that of the graft are too feeble; if the latter should be vigourous, it would be best to leave three or four sprigs of the former. These sprigs would divert a part of the sap, which sometimes flows with an abundance injurious to the graft. This precaution is more necessary when the plantation is exposed to strong winds; for these sprigs may be converted into props for the better security of a graft of quick growth.* Under this protection, a scion may be suffered to lengthen out its shoots without the necessity of topping them, in order to prevent accidents, when they exceed a foot in length.

In addition to these little but most essential cares, whenever it should happen to rain after the grafts shall have begun to grow; it would be advisable to look to them during the first intervals of rain. It is the favourable moment to seek for snails and slugs, which are so apt to ravage the shoots of young mulberries. These destructive

* This advice ought to be practised with much caution. Some years ago, I had a pear graft which had put forth with great vigour; and I left about it two or three long twigs for the purpose of diverting part of the sap as well as for its protection. A high wind pressed these twigs with so much violence against the graft as to cause its rupture at the point of junction. When, therefore, it should be requisite to leave any twigs for the above purpose, it would be advisable to top them, in order to obviate the danger by presenting a smaller surface to the action of violent winds.

animals take the field in damp weather, and direct their course to the tender grafts, whose buds they browse to the heart, and totally destroy.

CHAPTER VIII.

OF PRUNING THE MULBERRY TREE.

As we have already, in treating of the management of the young mulberry, spoken of the use that is to be made of the pruning knife with regard to them; we will in this place only add, that these young plants exact annual care, but always relative to the quality of the soil, to the space which they occupy, to the species, whether dwarf or lofty stem, to their age, to the quickness or to the slowness of their growth. An attentive proprieter will soon discern the imperfections in the form and in the growth of his trees, and will have the laudable ambition of giving them that shape and that vigour, which mainly constitute the beauty and the product of his plantation.

In some districts, mulberry trees are trimmed every three years; in others, every two years, but in very few, yearly. It is usually done in the

first days of August, after the gathering of the leaves. Pruning in the spring has, however, ultimately one advantage; it forces the tree to put forth a greater number of new shoots, which yield a large crop of leaves in the following year. But we advise the *annual pruning* of the high stem mulberry immediately after it is stripped of its leaves, as it is practised on the borders of the Gordon, in the diocess of Uzes. We know at St. Chaptes, in that district, a considerable landholder, who possessed the most beautiful mulberry trees of the province of Languedoc, who, besides giving to his trees every other attention which they required, had them pruned without delay after gathering the leaves. His trees yielded him an average income of fifteen to twenty livres a year each; because by this well regulated pruning, by a proper application of manure, and by seasonable tillage, he forced them to thrust out a quantity of new shoots, which, in the following year, were loaded with well-nourished and heavy leaves, that he sold at six livres the quintal. We cannot give a stronger evidence of the good effects of proper management in the cultivation of this useful tree.

All fruit-trees require more or less pruning, for the promotion both of their extrinsic beauty, and of the owner's profit. But there is another reason for applying it to the mulberry, and that is, on account of the ravages caused in stripping off the

leaf; in which operation the most skilful gatherers will sometimes twist or break the branches, and lacerate the bark. If an early remedy be not applied to these injuries, the trees become bristled with snags, that disfigure it, and obstruct the gatherers, when in the succeeding years there is a demand for the leaves. Besides, if neglected at this critical time, the mulberry tree lines itself with crooked branches of slender growth, that produce small leaves, and divert the sap from the flourishing branches which bear the richest foliage; and moreover, render the task of plucking longer and more difficult.

The pruning knife must take off not only the dry and the withered twigs, but also every thing that relates to an excrescence. Under this head we comprise the twisted, the slender, and most of the short shoots which grow along the large branches, but more especially those so well known by the name of suckers. We must also amputate those well favoured branches which crowd too closely upon the neighbouring ones; and above all, those that interfere, and by their friction, cause wounds which become gangrenous by the admission of moisture, and certainly terminate in the death of the branches, if not of the tree.

If we have a little experience in the cultivation of trees, we do not fear the free exercise of the saw and the knife, in taking off wood from those that have been a long time neglected. Most proprie-

tors, restrained by their fears, or influenced by their negligence, do not half remedy the evil. But a mulberry tree that has been suffered to over-burden itself, and which has been amply discharged and thinned out in the spring of the year, will supply itself with new wood before the close of the growing season, and will give a good income in the following one.

In pruning, we ought always to cut close to the branches ; to make smooth work, leaving no stumps to prevent the new bark from closing the wound. The small branches which form the compass of the head of the tree, and which have generally the defect of being too slender for their length, ought to be shortened at their extremities; and in taking off boughs that are crowded, we must cut close to the angle of the fork, always lopping the oldest wood, whenever it can be done with due regard to the form of the tree.

In order to restore those mulberry trees that may be weakened by repeated annual gatherings of their leaves, we allow them one season of repose, without stripping a leaf; but manuring them plentifully, and giving them, in the course of the year, two or three shallow tillages with a plough ; and where that cannot be used without injury to the roots, the hoe must be employed, and is always indispensable about the trunk. By this management the tree retrieves its vigour, and afterwards

produces abundant crops. Unthriving, and even very old trees, largely compensate the proprietor for the pains that he takes to renovate them.

Like all fruit trees, the mulberry that is stunted by the neglect of pruning and tillage, or that is exhausted by years of produce, may be headed down, and by this operation carefully conducted, be made to bear a new top, often equalling, in vigour and beauty, that of any one of our finest trees, and for many succeeding years contributing a full share of income. In this operation likewise, the cuts must be pared smooth, and be made to form a considerable angle with the horizon, in order that the water of rains and dews may run off freely.*

* In this chapter on pruning, the Author of the original work of which this publication is an abridgment, very properly recommends cutting close to the fork and paring smooth the surface of the cut; but he leaves the wound exposed to the drying heat of the sun, which causes small crevices in the wood, in all cases of amputation of large limbs. The moisture arising from rains and dews, penetrates these crevices and produces gangrene, before a new bark can cover so large a space. Mr. Forsyth had not then invented his mastich, which operated like enchantment in filling his purse, but had no such magical power, as he pretended, in the cure of trees. In the springs of 1800 and 1801, I made thorough trials of his composition, following in every particular the directions which he gives. But in every instance the experiment failed to exhibit the result which I was led to expect. For on removing the application in the following years, the wood which it covered was found to be discoloured and unsound to a considerable depth, and the new bark had made but little progress over the surface of the wound. When used likewise in

CHAPTER IX.

ON THE DISEASES WHICH LAY WASTE OUR MULBERRY PLANTATIONS.

Every species of tree is liable to some peculiar malady; and when the interest of the proprietor is

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the operation of grafting, it was found by me, and by several of my neighbours, very little, if in any thing, superior to the usual application of cow-dung and clay, and much more filthy even than that. They were both sufficiently ineffectual to induce the trial of something else. Accordingly in the spring of 1802, I put several grafts to which I applied the shavings of beeswax which I warmed, in order to make them adhere to the wood. But the wax was not adhesive enough to resist the effects of air, sun and moisture, and at the end of five or six weeks, I was obliged to renew the application. Nevertheless, the scions took promptly and put forth with great vigour. At the close of the season I perceived that the wood was not discoloured, and that the formation of the new bark was greater than I had ever before seen in the same space of time. These important results made me endeavour to find something to mix with the wax, which without destroying its beneficial effects, would cause it to hold more firmly to the wood. Accordingly, in the autumn of the same year, I dissolved a pound of bees-wax and a pound of soft turpentine together. The mixture was well stirred, and then poured into a basin, to cool; the bottom and sides of the vessel being first abundantly greased in order that the cake might be easily taken out. The next day I removed the bees-wax from

awakened by the value of the object, he applies the means of cure already known, or has recourse

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the grafts, and by means of a chafing-dish of coals and a knife, the cement was spread in its place, about the thickness of window glass, and carefully pressed so as to leave no passage to moisture or air. Several times in the course of the succeeding winter I examined those grafts and found the mastich unbroken and adhering closely to the wood. No accident occurred to them, and in the following season the new bark completely covered the head of the stock.

I afterwards made an alteration in the relative proportion of the two ingredients, by using two parts of soft turpentine and one part of bees-wax, and I have found it, in every respect, as effectual as the first method, and there is a saving of nearly one third in the cost.

At the beginning of May, 1806, I had two branches of a pear tree sawed off close to the trunk; the cuts were pared smooth, and formed an even surface with the body of the tree. The cuts were, one of them four inches and a half, the other four inches in diameter. The largest of the two I covered with the cement, about one tenth of an inch in thickness, and the smallest I left to nature. Both of them being cuts perpendicular to the horizon, and on a line with the bark of the tree, and shaved perfectly smooth, there could be no lodgment of moisture upon their surfaces. In that state they were left three years, but before the expiration of the third growing season, the wound which had been covered with the mastich was entirely closed by new bark, and a ball of cement, gradually pushed out of its place by the advance of that new growth, then hung by a small thread of the cement against the body of the tree. It will now be a matter of gratification, if not of instruction to the reader, to examine with me the condition of the wound left for nature to heal. It will be recollected that this cut was half an inch in the diameter smaller than the other, and I must now add, that its distance from the ground was nearly eight feet, in a south-west exposure, and within an inch of the height of the other, which was on the south-east side of the trunk. I found about one half of the diameter of this

to some remedy of his own, which he thinks the nature of the case requires.

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naked wound covered with new bark, and the wood of the remaining part discoloured, and of a blackish hue. On applying the chisel, it proved unsound, and the rot extended so far beyond the uncovered wood, that I was obliged, in order to take off all that was decayed, to cut away the new bark to its full extent on the sides, and more than an inch beyond it on the lower part of the wound. Besides, the gangrene had penetrated more than two inches into the trunk of the tree. However, I cleansed thoroughly the cavity, and left not a particle that was decayed. I pared, or rather cut, as smoothly as I could, this ugly hole, and then covered it a quarter of an inch thick with the cement. But I had the satisfaction of seeing this deep and widely spread wound gradually diminish in size, and afterward beautifully cicatrize at the end of four years.

In many cases where I have recommended the use of this mastich, and in several of my own, I have inspected the wood a year and in some instances two years, after the application of this valuable cement, and I have never found it discoloured or unsound. In grafting, there is, as I believe, no application that promotes so quick and so thrifty a shoot from the scion as a coat of this mixture; because I know of none that so effectually excludes air and moisture, and that is, at the same time, so congenial to vegetation. Under its protection, the sap is neither evaporated by the air, or its vegetative power destroyed by dilution with water, but it carries on its unseen, mysterious operations without interruption from these external causes.

This cement may be applied, with equal effect, to cover the incisions made in budding trees, which often on the failure of a bud occasion a dangerous rot. Likewise in cases of bruises, the bruised bark and wood must be cut out and the cavity must be forthwith covered with the cement. It may happen in very thin applications of this composition, that the contraction, by extreme cold in winter, will cause it to crack, or that in summer, a high temperature of the atmosphere, with a hot sun, will occasion it to melt, and lay bare some spots on the surface; in both cases,

Our mulberries in Languedoc and Provence are subject to three peculiar diseases, two of which are more generally prevalent: One of them seizes the trunk, and the other the roots of the tree. The third, which is a malady of the branches, is not so common, but is readily discovered by the blackish colour of the bark. On close inspection thousands of little insects, resembling those that are found about orange trees, are discovered in the channels of the bark from which they drain the sap. These destructive insects, if unmolested, often raise the bark entirely around the branch, and sometimes penetrate to the foot of the fork. The evil is fortunately not without its cure, and the remedy is always at hand. That part of the branch which is severely attacked by this vermin must be cut off, and the residue must be thoroughly cleansed with an instrument of iron or of wood. The same process must sometimes be repeated in

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the spreading of a little fresh cement with a heated knife, will mend the injuries. I cannot close this long note without expressing my belief that the superior efficacy of this composition, and the neatness of its application, will ultimately recommend it to the use of all cultivators of trees. The facts which have been here stated may not be sufficient to bring it into immediate adoption. But let its properties be put to the test by the horticultural and agricultural societies of England and of the United States, then, under their patronage, its benefits would soon be extensively felt.

the succeeding year, which generally relieves us from their depredations.*

As to the malady that attacks the trunk of the mulberry tree, it is easily perceived, and our husbandmen in Provence and Languedoc are alarmed at its progress and its destructive effects. It is a sort of ulcer which breaks forth almost always in the middle of the trunk; rarely on the north side, still more uncommonly on the east, but usually on the south or the west sides. When the moisture flowing from this ulcer increases sufficiently to reach, and actually attains the roots, the mulberry tree soon perishes. We attribute this malady partly to the setting of plants that are more than four years old; for the stem becomes hard and dry in proportion to its age, and taken from its

* This insect may be peculiar to the southern parts of France; or it may be generated, as many insects appropriate to particular species of trees undoubtedly are, in the decomposition of parts of the tree; and from the very nature of its formation, it instinctively seeks the sort of food that best assimilates with its temper of body. Be this as it may, I have never seen or heard of a vermin of this kind in the State of Rhode-Island, though it may hereafter show itself, if the mulberry tree should ever be extensively cultivated here. Moreover, the remedy which my intelligent author recommends, is not the only one, nor perhaps the best. All insects have a horrible aversion to the pungent alkali contained in soot. To some of them it is fatal, and they will all escape from it if they can. Let, then, some pulverized soot be scattered in the channels of the bark attacked by this or any other vermin, and the dews or the rains will soon fill these channels with the liquified alkali, and cause flight or death.

native soil at a more advanced age, is more affected by drought and heat, and thus losing part of its original moisture, receives the seeds of future disease. We think that the evil may be obviated in some measure by procuring plants under four years old; by the selection of a good soil; by the pouring of water plentifully into the holes when they are set; by waterings at proper intervals, especially in the first year of the plantation; by giving always sufficient space, and by guarding them from the heat of the sun with an envelope of reeds, or of leaves or bushes about the trunk. These attentions are of vital consequence; for a mulberry plantation contributes largely to the comforts of the proprietor, and when well managed, becomes to him a source of wealth. He will soon feel the all important difference between a healthy and vigorous tree producing abundantly, and one that is sickly and yielding a poor crop.*

* The trunks of other trees besides the mulberry, are sometimes attacked by ulcerous appearances. I have a valuable cherry tree, upon the stem of which, some years ago, there broke forth an orifice, somewhat of the kind described in the above paragraph. When I found that its ravages were fast spreading from the centre, I applied the knife, and took out a circular piece of the bark, sufficiently distant from the diseased part, and clean to the wood, which I scraped where I found it necessary. A coat of the bees-wax and turpentine was immediately spread over the incision, extending it a little beyond the edge of the wound, and in two growing seasons the cut was handsomely closed, and has remained sound ever since.

The malady which attacks the roots of the mulberry, is the most dangerous of the three. We at first only suspect its existence, for, without laying bare the roots, we cannot see it. We ascertain it pretty well, however, when, at the first shoot of the spring, the leaves show themselves of a pale green, afterwards turn yellow and gradually dry up and fall off. One may then rest assured that the branch which nourished them is deprived of vegetation, and is in fact dead. This partial mortality, if neglected, will spread to the neighbouring branches, and will terminate in the death of the tree. The experiments that we have made induce us to recommend confidently a mean of cure in this complaint, which becomes hopeless if too long neglected. In order, then, to arrest the further progress of this morbid affection, we have opened the ground, and laid bare the roots perpendicularly to the yellow leaves, or the dead branches. We have found these roots of a deep yellow colour, and sometimes black and full of moisture, and often having the smell and the taste of the mushroom. The dark colour of the roots is distant from the trunk of the tree in proportion to the gravity of the distemper. Without delay, the roots which correspond perpendicularly to the affected branches must be cut off close to the trunk, and if there should be any unnatural darkness of colour in the neighbouring roots, they

must also be amputated in the same manner. By this simple treatment the tree revives, and yields, the same year or the following one, its usual quantity of leaves. The proprietors, in these two southern provinces of France, have suffered severely by the ravages of this disease; and we trust that they will in future find relief in most cases, by adopting the means which we ourselves have practised with great success.*

* There is now, whilst I am writing this note, a disease raging among our peach trees, similar in its external appearance to that described in my author's last paragraph on the mulberry. It commenced here on this island the last year, by the withering of a few branches in a number of trees of that species. The fruit which hung upon these branches shrivelled, and ultimately dropped off, the leaves having taken rather sooner the dark colour of death. The trees which were first attacked have many of them perished; and the malady, in the season which we have just passed, has spread with an alarming rapidity. The only remedy yet adopted is the amputation of the diseased limbs; and it remains now to be ascertained, whether that measure will cure the evil. But if, as in the case related of the mulberry tree, the seat of the distemper exist in the roots, it will be requisite to lay them bare, and to apply the knife to those that are infected.

BOOK THE SECOND.

OF THE

RAISING OF SILK WORMS,

OF THE COCOONS,

AND OF THE

MANNER OF WINDING THEM OFF.

We come now to the main object of this Treatise, the profitable business of raising silk-worms. As this is generally with us one of the sources of industry of a class of people which more particularly needs instruction on this subject, we have thought that it would be useful to present to that class a summary of that progressive course of management which would best secure the success of its labours; but rejecting from our inquiry all those minute details which would only serve to gratify the curiosity of the naturalist.

If we have, in the preceding Book, extended our reflections upon the properties of the different kinds of mulberry, and upon the minute cares required in their cultivation, we had in view the interests of the proprietors, the greatest number of whom are enlightened men, not only capable of understanding, but of improving our imperfect suggestions. We will, then, now endea-

vour to fulfil the final purpose of this work, by giving, in a plain and concise manner, to those who undertake to raise the silk-worm, sure and easy rules for obtaining a successful result.

CHAPTER I.

OF THE CHOICE OF A PLACE, AND THE ARRANGEMENTS FOR A COCOONRIE, AND OBSERVATIONS UPON THOSE THAT ARE ALREADY CONSTRUCTED.

The building prepared for the reception of silk-worms ought to be in proportion to the quantity of seed which we wish to have hatched, and that must always be subordinate to the measure of mulberry leaves that one may obtain. The dimensions of the building ought consequently to be regulated according to the present means and the future views of the proprietor. The fabrick should be erected upon a dry soil, at a distance from all bad exhalations; and when built of brick or of stone, it would be most suitable to have it arched. All the openings, the windows and the doors, must be made on the north and on the east sides. Apertures on the south and on the west,

are destructive to silk-worms, especially in very warm climates.*

The houses of some poor people who raise silk-worms, are not generally arranged according to the above rules, and the apertures of their rooms are frequently on the wrong sides. But their kitchens, in which they usually raise their silk-worms, are so warm, and the windows are so well closed, that the worms thrive exceedingly well till their fifth age, or the last change of the skin, when they lose great numbers of them by too much h fir, and by the neglect of a change of air.

An arched building, when we wish to operate on a large scale, has many advantages. The leaves collected for the worms are deposited under the arches on the ground floor, and the rooms for the silk-worms are formed above them. Four openings about a foot square are made through the arches, for the purpose of renewing the air, and of

* Experience alone can inform us whether this observation be strictly applicable here. Dampness and rain generally attend westerly winds in France; whereas, in all our Atlantic States at least, it is the easterly wind that is productive of rain. This difference is the result of the inverse position of the ocean to the two countries. Now, whether the fatal consequences arising from the exposure of these worms to the western air in France be the effect of moisture, I cannot positively say, since my author is silent respecting this point. But I think that there is good ground for presuming that the caution is given by him for that reason; because he, in various parts of his work, warns us against the dangers of wet, or even of damp leaves.

clearing off the litter. The corners of the room are appropriated for the construction of four fire places, in which fires are made when necessary to maintain the heat at a proper degree. When the establishment exceeds the length of twenty-five or six feet, we commonly raise two other chimnies midway in the walls of the two longest sides of the room, in order to keep up a due temperature without the risk of making large fires.* For the sake of economy, the arch, upon which this building is raised, may be of small elevation. Six and a half feet above the soil will suffice, but the height of twelve feet at least must be given to the story above, and it must likewise be perfectly secured against all animals and insects. The ranges of shelves for the reception of the worms are usually made six feet long and three feet wide, with a distance of three feet from each of the two upper ranks to the one immediately below. A passage of three feet and a half between the ranges will be necessary for those who have the care of the worms, and will serve for the renewal of the air. A breadth of twenty-seven to twenty-eight feet, will admit of four

* A stove would unquestionably answer the purpose better than all these chimnies, because the pipes might be so conducted as to diffuse every where an equal warmth; and we should thus avoid the hazard, inseparable from fire places, of throwing too great a mass of heat into particular parts of the room.

ranges of shelves, of which the two wall ranges, placed two feet from the walls, in order to facilitate the circulation of air, may be continued close to the ends of the room, but the intervening ranges must terminate within three feet of the wall. By this distribution a building of thirty-six by twenty-eight feet, will accommodate one hundred and thirty thousand of silk-worms. We will however here observe, that it is best to delay the conveyance of the silk-worms to this spacious habitation till after the third change of the skin, taking first the precaution of making fires to expel the moisture and warm the air. Before this epoch, they must be confined to a smaller, warmer and less airy space. A room about eight feet square, and seven or eight feet from the floor to the ceiling, ought to be appropriated to the hatching of the eggs, and to the care of the worms in their three first ages, as we shall more particularly describe in the third chapter. Such a lodging is very propitious for them at that time, provided that they be kept warm, well nourished, thinly scattered, and guarded from too much light. We have now terminated the construction and the internal arrangements of the large room. As to those who have not the means of erecting any thing upon this plan, and undertake this business in a small way, we shall merely recommend as a general rule, even if they have no window to the

east or to the north, to keep the others scrupulously closed, covering them with a curtain till the worms attain the fourth change of the skin.

CHAPTER II.

OF THE CHOICE OF THE SEED.

*That which we call the best Spanish seed, ought to be of an ash-coloured grey, with a slight tinge of purple. It produces cocoons of a pale flesh-colour, which the silk merchants prefer because it is of a stronger and more glossy thread.

* At the commencement of this chapter, my author has inserted a line on the origin of the silk-worm in Europe. But whether it was first brought to the Peloponnesus after the conquest of the Persian empire by Alexander, and from thence conveyed to Sicily and to Spain; or its eggs carried from China, India, or Persia, in a hollow cane, to Constantinople, by two monks, are things of minor importance to us than the science of every thing necessary to its successful introduction here. In our present state of neglect and ignorance of this interesting subject, the product of that valuable little worm cost us, the last year, more than ten millions. By learning and practising the instructions contained in this Treatise, we shall free our country from this enormous tribute to the industry of foreign nations; and then these accumulating millions will remain at home, to increase our means of internal improvements, as well as our own domestic comforts.

If good, it crackles when crushed under the nail, and sheds a glutinous and transparent liquor; but if it is bad, it diffuses a fluid as liquid as water. Moreover, when the grain is addled, its colour is a dirty white; and when its quality is somewhat impaired, it exhibits a deep brown colour. The first is consequently sterile, and the other produces sickly worms, which generally die at the fourth change of the skin.

We recommend the choice of small and bright seed, of a grey colour more or less dark, according to the colour of the cloth from which it was detached. Besides, it is advisable to renew the seed every three or four years; and for that purpose, the cocoons, in case we wish to produce our own seed, otherwise the seed itself should be procured at a reasonable distance from our establishment, not less than three or four leagues.* Furthermore, our experience has taught us, that

* Many of the peasantry, and of the small tenants in the southern departments of France, to avoid the trouble of producing, and the cares of preserving, their own seed, prefer every year to purchase the little portion which they may want. But although this object of their industry be limited by their ability of pursuing it, yet they generally derive from this source the means of paying their taxes, and of increasing their domestic enjoyments. The observations to which this note refers, appear to have been written principally for the instruction of that interesting class of men; but they may also be useful to those who produce their own seed; and especially to all those who, for the improvement of the breed, find it necessary to procure it from another district.

those who operate on a plain, succeed best when they make their exchange, or purchase in a hilly country; and those who are established among hills when they obtain their seed from the plain. This rule is certainly applicable to most vegetable productions; and we warrant its efficacy in meliorating the race of animals. Those who have large establishments in Province and the lower Languedoc, and who wish to secure the greatest advantages resulting from a change of seed, should procure it from the upper Languedoc, or from Dauphiny, and even from the environs of Grenoble itself.

CHAPTER III.

OF THE HATCHING OF THE SEED OF THE SILK-WORM.

In order that the following precepts may be rendered more interesting to the reader, we must here premise that an ounce of seed, when well chosen, produces forty thousand of worms, which will consume, in the course of their existence, nine hundred pounds of leaves, each worm eating its own weight of leaf every day. Two thousand five hundred worms yield one pound of silk.

Thus we may pretty nearly estimate our enterprise.

We will now proceed to the present object of our inquiry. After having chosen the silk-worm seed with the most scrupulous attention, and limited the quantity according to the mulberry trees which we possess, or the leaves in our neighbourhood that we can command, we may proceed, soon after the first appearance of verdure on the mulberry, to the operation of hatching the seed. There are two methods of doing it: one we shall call spontaneous; the other is artificial.

The spontaneous hatching is managed in the following manner: The seed is spread upon white paper, placed on a clean table, separating each ounce of seed, and leaving a space of six or eight inches all around each parcel, for the reception of small leaves of the mulberry, which the silk-worm eagerly attains as soon as it is hatched. This table, of a size proportioned to the quantity of seed that we intend to spread upon it, ought to be placed in a room seven or eight feet square, and seven or eight in height, closely wainscotted or plastered on all sides, having a glazed window on the east side, with a fire-place, (or still better, a stove,) for the maintenance of a proper temperature. Three tiers of shelves, two feet long and eighteen inches wide, with a distance of two feet between the lower and the middle, and between the middle and upper

tiers, must be established along the extent of two of the side walls. A fire must be made in this little room early in the morning, at noon, and at ten in the evening, for three days before the seed be placed in it, in order that the air and the walls should be made dry and warm. The temperature of the air, during the first twenty-four hours after spreading the seed, must be maintained at 77° to 78° of Farhenheit; and in each succeeding day the heat must be increased two degrees, till it shall arrive, on the seventh day, at ninety-two or three degrees, when the worms will probably begin to make their appearance. Exposed to this graduated heat, the shell of the seed, on the sixth day, appears much whiter. It is then that we must be unremitting in our cares; turning the seed every four or five hours, and preserving an equal temperature. Those which put forth before the seventh, or after the tenth day, are delicate and sickly. The heat, therefore, ought to be graduated with due reference to the climate of the region where the worms are bred; and in countries where the heats begin early, great attention and much experience are necessary to prevent an untimely exclusion.

In the manner above detailed, we ourselves have succeeded in hatching ounces of seed with very few failures. A fortunate breed of silkworms, produced in this or in the artificial way,

depends as much upon a well regulated progressive heat, as upon a season favourable to its birth and after-existence. The harvest of cocoons is also dependant upon well managed hatchings. Silk-worms judiciously produced, give less trouble and more profit. Let us then always examine the complexion of the seed; ascertain that it has wintered in a temperate place; that it has not been heaped together a long time without being shook, and that it has been guarded from the heats which sometimes occur at the close of the winter and in the beginning of spring. The seed ought not to be spread for hatching till the season for frosts be passed, and however forward the leaf, the exclusion of the worms must not be pressed by increasing the heat, which ought in no case to be raised higher than ninety three or four degrees.*

* Though my intelligent readers were led, early in this chapter, to expect as clear and as minute an account of the artificial method of hatching as of the other, yet, with all the regret of disappointing them, I have concluded to suppress it. The trouble attending that process, the strangeness of the management, a sort of incubation, (for one charged with the production of the brood keeps his bed six or seven days;) in fine, the detail of all the circumstances would here be useless, for no one among us would undertake such a task. The French, with an uncommon buoyancy of spirits and an extreme vivacity of character, will, to attain certain ends, submit with a wonderful patience to great inconveniencies. But that peculiar way of producing the worms was probably adopted and generally practised among the poorer classes, for the want of means of constructing an appropriate room and of providing themselves with fuel and a

CHAPTER IV.

OF THE FIRST AGE OF THE SILK-WORM.

As soon as the worms come out of their shells, they seek and cling to the mulberry-leaves, which, after the seventh day, are spread around the different masses of seed. As fast as the leaves become loaded with silk-worms, they are taken by the stalk, to which the worm rarely attaches itself, and conveyed to the shelves. We have found it to be of some importance to place the worms of the morning's birth upon the lowest tiers of shelves, because there will then be a greater equality of the brood in each mass. In developing our system, we shall give the means of obtaining more uniformity as to size and forwardness in all the different masses.

As soon as they are placed, without being crowded, in their enclosures, they must be supplied with leaves of old mulberry trees, cleansed from all impurities, and coarsely chopped. The

thermometer to regulate the heat. Thus, like many other peculiarities, from some one of which no nation is exempt, it has obtained and become a custom.

temperature of the air must now be maintained from seventy-seven to eighty degrees. Indeed, they may be inured to a higher or to a lower temperature; but twenty years of experience have taught us that the above limitation is attended with the best result. Moreover, it is essential to allow them sufficient room in their different enclosures, because from their birth to their last state, they throw off small threads of silk, which embarrass them less when they have more space, and because they are less exposed to become diseased. Leaves cleansed and chopped are more suitable at this age, when the teeth of the worm are not sufficiently firm to cut with ease the leaf when entire.* In this first age of the silk-worm, the chopped leaves ought to be distributed to them abundantly three times in the day, and once at about ten o'clock in the evening. As they advance in this early stage of their existence, if they consume readily their food, and appear eager, an addi-

* This hashing of the leaves may enable the little animal to fill itself sooner. But most of my readers will hold with me, that a beneficent Providence has wonderfully furnished the minutest animalcule with the organs necessary to take the species of food best adapted to its existence; and we find to our cost, that the smallest caterpillars, on issuing from the egg, have teeth sharp and strong enough to prey upon the foliage of our trees, and if left to themselves, they soon convince us by their numbers, their increase of size, and the naked state of the branches, that very few of them have died of famine from an inability of grinding their food.

tional distribution may be made to them every twenty-four hours.

We need not be disquieted at the different colours of the silk-worms at their birth. These various hues are probably caused by the various degrees of heat applied to the hatching process.* The predominating complexions are the ruddy, the black, and the ash-coloured. Those of all these colours succeed equally well, if carefully tended; more especially in their first age. But we must not rely much upon those of a deep brown colour. They usually trail at their birth and at their different changes, and diminish to half the common size at their ascent to form the cocoon.

It sometimes happens, in very backward springs, that we cannot obtain fresh leaves for our silk-worms, or that those which have put forth are injured by frost. In order to meet this difficulty, we generally, on a dry and clear day of autumn, gather the mulberry leaves which have fallen of themselves, because they are less apt to become

* With due respect for my author's opinion, I should rather attribute these differences of colour to the different positions which the seed occupied when kept in a mass through the preceding autumn and winter. Although it were shaken several times during that period, yet it is presumable that the seed which remained longest at the surface of the mass and received the benefits of the air, would produce worms of a different hue from those which come from seed confined, almost without vent or air, in the centre of that mass.

musty in the course of the winter, and we deposit them upon clean straw, under our arches, or in any proper place, sheltered from sun and moisture. Before these dried leaves are offered to the silk-worms, they must be spread upon a clean cloth for some days, in the cellar, for the purpose of softening them. Thus, by much care, and all those appropriate and indispensable attentions, we lead this profitable little animal, at the end of six days, to its first dormant state, which results in the change of its skin.

CHAPTER V.

OF THE SECOND AGE OF THE SILK-WORM, AND FIRST CHANGE OF THE SKIN.

When the worms reach that diseased state, vulgarly called among us *moulting*, they become glossy, lose their appetite, contract in size, and hide themselves, in a condition of lethargy, under the remains of the leaves. At that time the muzzle is more slender, the whole body is languid, and they refuse to take any nourishment. This critical situation was preceded by a voracious appetite

of several days' duration, wisely ordered for the purpose of stretching the first skin, which now becomes flaccid and dry. The worms extricate themselves from this useless covering, which otherwise would become fatal to them. They are very diligent in their endeavours to quit it. The head is the first part disengaged; and this dry skin glides progressively to the other extremity of the body, and the little animal issues forth in a new garment.

Whilst the most forward are struggling through this constitutional change, leaves, *always gathered by clean hands*, should be lightly distributed for the nourishment of those that are more tardy, and that still require supplies of food to enable them to reach, in good condition, the hour of repose. It is of vital importance to avoid dealing leaves that are wet, or heated in the sun, at any time; and more particularly in this state of malady. But if, at this crisis, fewer leaves are requisite, a little diminution of heat is necessary. It will be readily conceived that silk-worms concealed under the fragments of leaves do not need the same degree of warmth, and that it will then be proper to reduce the thermometer four or five degrees, by the admission of fresh air.

When the worms show themselves again upon the litter, they have a larger snout, and not so black as it was before the change; the body is longer, brighter, and less marked with different gradations

of colour. Those which first appear, must be placed on the lower shelves, which ought previously to be made perfectly clean ; and proceeding agreeably to this rule, the most tardy will be lodged in the upper tier. By this attention we effect a greater equality among the individuals of the whole brood; which equality the higher degree of heat in the upper shelves tends to promote. In order to attain as near as possible this desirable condition, we often have recourse to an additional portion of fresh food, distributed in the course of the night to those which are behind hand. We acquire by these means an uniformity of growth which considerably diminishes the cares that we are obliged to bestow at every change. They are now eager for food, and cleansed and hashed leaves must be given to them four times from the rising to the setting sun, and once in the night.

CHAPTER VI.

OF THE THIRD AGE OF THE SILK-WORM, AND SECOND CHANGE OF THE SKIN.

The state of torpor of these worms presents always the same appearances. It is at the end of

five or six days, more or less, according to the attention and skill with which they have been treated, that they arrive at the second change of the skin. The same methodical management must be pursued. The lower shelves must first be well cleansed for the reception of those that are most advanced; and the other shelves are successively prepared in the same manner, to lodge the remaining ones proportionally as they issue from the skin. The different subjects are thus placed in regular order, and in the most suitable position for obtaining more uniformity at every subsequent change. Each shelf will now make two shelves; and if their nourishment have been of good quality and regularly distributed, it may be found necessary to allow three.

As soon as we shall have placed the worms in their lodgings, and shall have removed the litter, it will be useful to perfume them by burning a little thyme or juniper in the room where they are kept, and during that and the following day, the temperature of the air ought to be reduced three or four degrees. The state of convalescence, which continues from twenty-four to thirty-six hours after their malady, is a painful condition, and it ought to be favoured by cleanliness, silence and obscurity. Cleansed and hashed leaves ought to be given to them every four hours through the day, and twice in the course of the night, as soon as they shall have passed their convalescence.

We would urge here again the propriety of giving one portion less to the most robust masses on the lower shelves, in order to promote an equal degree of vigour and size in those that are not so forward.

CHAPTER VII.

OF THE FOURTH AGE OF THE SILK-WORM, AND THIRD CHANGE OF THE SKIN.

If small collections of silk-worms have generally succeeded better than large collections, it is because they have been less crowded, and have been more easily and more regularly attended. Results equally fortunate will be derived from the most extensive establishments, provided the worms be thinly scattered, be regularly fed, and be treated with due attention as to cleanliness and temperature. Although we have prescribed a heat from seventy-seven to eighty degrees, yet we are not ignorant of the fact that they may be raised without the aid of fire. But we know also that when they are thus exposed to the changes of temperature, which usually occur during their vermiform

state, unless the heats of the season should chance to be continual, they will not begin to spin before the expiration of sixty days. On the other extreme, if the mercury should be maintained at ninety-eight to one hundred degrees, they will begin to spin in twenty-four days.* The limitation of seventy-seven to eighty degrees, which our successful experience authorises us to recommend, is that mean point between the two which most effectually secures the health of the brood, and brings it to the spinning state in about forty days. But this temperature must be accompanied by a regularly distributed and abundant nourishment, except during the times of lethargy and of convalescence, when the leaves should be sparingly scattered to them every five hours, taking care to discard all that may be found yellow or blighted.

The brood has now arrived to a state of vigour, and to a size which require more space and less confined air; it becomes therefore requisite to remove them, immediately after their recovery from this their third lethargy, to the shelves of the large room. The walls of this lodgment must previously be made perfectly dry by fires, kindled in the different chimneys, (*or in the stove,*) for two or three days before their removal. The

* In this high degree of heat, many of the worms must become sickly, and perish. Moreover, by driving them to this early maturity, the harvest of silk, I presume, must be less abundant.

temperature of the air in their new habitation, at the moment when they are carried into it, ought to be regulated at seventy-seven to eighty degrees.

If the worms have happily advanced in a healthy condition to this their fourth age, three or four of the small shelves of the little room, will make one of those to which they are now conveyed; but should they, through bad management, or some casualty, be in a less prosperous state, it may require five or six of them to fill one. But here also, as well as in their first lodgment, their enclosures, and all parts of the room, must be made perfectly clean, and the litter be every other day removed. We here again, at the close of this chapter, repeat our general maxims, lest it should be forgotten, that throughout the course of their four first ages, excepting the days of malady and of convalescence, they ought to be amply supplied with food; to be kept in an air of the proper temperature; to be thinly scattered in their enclosures, and to be carefully guarded from the bad effects of too much light.

CHAPTER VIII.

OF THE FIFTH AGE OF THE SILK-WORM, AND FOURTH AND LAST CHANGE OF THE SKIN.

From six to eight days after the third change, the silk-worms become whitish; they shrink and conceal themselves under the leaves; they lose their appetite, avoid the light, and seem to require only repose, silence, and retirement. It is again the same external show of disease, the same duration, and the same manner of escaping from this state of fasting and lethargy. They consequently need a vigilance equal to that which was necessary in their preceding changes, but with a different service of food; for the time is now arrived in which the silk-worm has the greatest appetite; and from this hour to that when they shall seek the spot for covering themselves with their cocoons, they will consume as many leaves as they have eaten from their birth to this day.

After placing them in their clean dwellings, progressively, as they recover from their torpid condition, on the second day following, the air of the

room must be purified, by burning a little vinegar, in which a few cloves have been infused; and the warmth of the room must be reduced seven or eight degrees. Then an abundance of whole leaves of the young mulberry trees must be distributed to them every four hours. It will be necessary, also, every second or third day, to clear off and remove the litter; and as this is the season of their rapid growth, a sufficient number of shelves must be ready to receive those which it may be found necessary to take from the crowded enclosures. Now it will be an object of economy to stir the mulberry leaves an hour or two after the distribution, and to raise the temperature of the air three or four degrees; for the worms are thus excited to consume all the remnants.

In extensive establishments it is needful, in these days of great consumption, to make large collections of leaves, and to deposit them under the arches, in order to have a sufficient supply ready whenever the gatherings are interrupted by rain. Moreover, we ought to secure the services of a number of persons adequate to the task of picking constant recruits of food; for it is now a matter of great moment to take every measure of precaution, because in eight or ten days we reap the fruits of our labours, if our own negligence do not cause the disappointment of our hopes. We therefore urge again the all important duty of keep-

ing them clean, and also cool, in this stage of their existence; of giving them sufficient space, and plenty of food. If these precepts be strictly followed, we dare to warrant complete success.

CHAPTER IX.

OF THE RAISING OF THE SILK-WORM TO FORM THE COCOON.

After two days of convalescence on entering their fifth age, the silk-worms pass eight or ten days more in satisfying a voracious appetite, in rapidly increasing their size, and in filling themselves with silky matter. They soon afterwards diminish in bulk, become transparent, of a lighter colour, and show some agitation. They crawl about continually, raise the head, and seek the shrubby thicket. Not a moment is to be lost when we perceive these signs of their immediate wants. The litter is without delay removed from the upper tier, and standards of twigs must there be raised in arches for their reception. For this purpose we may employ the sweet broom, the holm-oak, the bulrush, the box, the thyme, the willow, the lavender, or some branches of the

tamarisk; in fine, we must be governed in our choice of wholesome and proper brush by the productions in the neighbourhood of our establishment. We prefer the young holm-oak and the tamarisk, intermingled with stalks of dogs-grass and lavender. The feet of these arches of twigs ought to be twelve or thirteen inches apart, and every sprig of which they are composed must be dry wood, free from leaves and dust, and open enough above the ligatures to admit the free passage of the worms. The first which rise generally reach the top of the arches, place themselves there, and spin at their ease in this tufted shelter. In proportion as the litter is cleared away, and the worms removed from one shelf to another, we successively cleanse the upper tier, upon which we form the rows of arches; and progressively as the work advances, we pass to the middle tier, and terminate at the lower one, upon both of which we shall find it also necessary to establish ranges of arched brush. [See Plate I. two methods of making these arches.]

By far the greatest number of silk-worms, accommodated in this way, ascend and place themselves either in the arches, or among the twigs of the sides and supporters. There will always, however, remain some that trail, and that still require care and nourishment. Regular supplies of food are administered to them for twenty-four

hours, and afterwards all that are left are removed to enclosures which are denominated hospitals. These places are furnished with light and supple twigs, with foliage and dry sprigs of dogs-grass, placed on the floor in the corners of the enclosure. It is there that the worms, which are sluggish, or too full of silk, cast easily their thread, and form their cocoons in tufted shelters easy to attain. By furnishing these facilities to the worms that trail from a variety of causes, we procure valuable cocoons from most of them; whereas they would mostly perish without spinning, if left with no other resources but those furnished to the more healthy part of the brood.

When the silk-worms show an inclination to rise, all perfumings must cease, and the temperature of the air ought to be maintained at about sixty-eight of Fahrenheit. If the external heat should at this time be very great, we must use the means of giving them fresh and cooler air from our vaults. At this crisis the worms do better when the season is dry and a cool north wind blows.

The silk-worm employs ordinarily three or four days in making its cocoon. We usually detach and collect the cocoons ten days after the first formations, and we allow so much time because they do not all begin to spin on the same days. The worm remains in the chrysalis state fifteen

days, and then, piercing its enclosure, makes its appearance in the form of a white moth. We ought to recollect these dates if we are anxious to secure the rich fruits of our labours, as well as to provide seed for the brood of the succeeding year.

For the instruction of small proprietors, and of the poorer classes of peasantry, who cannot afford to make proper establishments upon this extensive scale, we shall merely prescribe as general rules, to maintain a temperature of seventy seven to eighty degrees, and to give cleansed and chopped leaves to their silk-worms every four hours from the time that they are hatched to the fourth change of the skin; to perfume them with thyme, or juniper, or rosemary, or vinegar burnt after their recovery from each state of change; to keep them thinly scattered upon their tables; to remove carefully the dirt, the litter, and especially the dead and the diseased worms;* and lastly to re-

* I have some reason to believe that all these rules are unknown, or neglected by those who raise the silk-worm in Connecticut, where a considerable sum, (30, or 40,000 dollars,) is annually realized by this business. For several years in succession, a worthy female came from that diligent State to this Island, and took charge of a brood of twenty or thirty thousand silk-worms, produced in alternate years on two farms in the vicinity of Newport. When I visited the establishment, the worms were at the last days of their fifth age, and were so crowded—the term is too feeble—they were literally so accumulated on the tables, that, as I then judged, there could not have been less than three hundred to the square foot. Many of them were diseased, and some

duce the temperature to about sixty-eight degrees, from the time of the fourth change till they confine themselves in the cocoon.

We have always obtained more success by the admission of a small portion of light, and by always taking it from the north and the east; and it may be of some utility to assign here our reasons for pursuing this rule. The silk-worm is provided by nature with twelve eyes; six on each side of the head, four of which are in the upper range, and two in the lower. The chrystalline humour of these eyes is so thin, that strong rays of light make a violent impression upon these delicate organs. We have seen them almost in convulsions when their eyes were struck by dazzling vibrations of light. We will not pretend that our view of the subject is perfectly philosophical; but we positively assert, that a long practice has proved to our conviction, that silk-worms profit best, and love to pass their lives, in a moderate obscurity.*

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of them were lying dead upon the stale litter, and those in health were crawling in multitudes over the sick and the dead, and over each other. Now this is barbarous; yet I was afterwards informed, that, notwithstanding such outrageous mismanagement, more than fifteen pounds of silk were collected from that ill-conducted brood.

* If my author had not, in various passages of his book, urged the importance of keeping the silk-worm in a moderate obscurity, and had not also led the reader to expect that he would assign his reasons for that advice, I should certainly in this abridgment,

It will serve to gratify curiosity, if it do not answer any other purpose, to mention in this place the silk-worm of Milan, which passes through three changes only. This is a smaller species, which begins to spin after the third renewal of the skin, and terminates its career eight days earlier than the common sort. The cocoons of this race are smaller, but well formed. The seed which they yield is as fair as that produced by the ordinary kind. These worms succeed best in the more southern countries. They require more heat, and much more food, in proportion to the duration of their existence. They attain a great size after casting the third skin, yield a considerable quantity of silk, and, by their early retreat, finally spare

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have suppressed the whole of the above paragraph. Few among us have ascertained the number of eyes in the head of a silk-worm; but as spiders and many other insects have more than one pair of eyes, let us be willing to take his statement of the number as a fact. But may we not, in opposition to his hypothesis, attribute those appearances of agitation and pain, to an impression similar to that which most animals feel when a glare of light is suddenly thrown into a dark retreat where they have been long confined? The silk-worm was probably first cast on the branches of the mulberry tree, in the open air and there exposed to the brightness of an unclouded sky. Does not, therefore, the homage due to the wisdom of a beneficent Deity, oblige us to believe that all their eyes were given to them for some valuable purpose, and not for their torment? It may nevertheless be true, as my author has asserted, that the silk-worm profits best in a moderate obscurity, and perhaps for the same reason that poultry is said to fatten sooner when deprived of much light.

our time and our mulberry leaves. The quick supplies of food, and the increase of heat, which this species requires, give to their cocoons more fineness and less weight.*

CHAPTER X.

OF THE DISEASES OF SILK-WORMS.

We will suspend, for a short time, the progressive history of the silk-worm; and whilst we leave it to repose in the chrysalis state, we shall attempt to treat of the accidental diseases to which silk-worms are liable, in the course of their different ages. After exposing the symptoms, and the probable causes of a malady, we shall either offer preventives, or, except in desperate cases, propose some means of cure. In our two southern prov-

* This peculiar species would succeed well in South Carolina, and in Georgia, where the temperature of the climate would suit this short lived race. The warmth of the first days of Spring would there produce plenty of food for an exclusion of the worms, early enough for them to reach the end of their career before the arrival of the sultry heats of the summer months. Those oppressive heats bring disease and death among a brood of silk-worms.

inces of France, we discover four distinct maladies which seriously attack our silk-worms. The *luzetterie*, the marasmus, the *grasserie* and the *dragée*.

1st. The *luzetterie* gives its name to the worms that labour under it. They are called luzettes, or shiners; and the name is expressive of their state. This malady extends, luckily, over but a small part of a brood; and the worms which are attacked by it always withdraw to the sides of the shelves, or to the borders of the tables. At the second or third cast of the skin, their complexion becomes greenish and glossy. They must be removed and thrown away; for they never pass the fourth moulting, and only resist for a short time their mortal disease, by eating less, and by separating themselves from the others, and rambling about the borders, where they have fresher air.*

2d. We call those worms *passis* which are harassed with the marasmus. This incurable disease is caused by an excess of heat maintained during the dormant states, and during the convalescences,

* Does not this very instinct, which here leads the little animal from the crowd to seek a freer air, indicate a remedy by which many of them might be saved? If, on the first symptoms of the disorder, they were taken from the enclosures and conveyed to a place where they would breathe a fresher air, and were then sparingly fed with the thin leaves of the wild mulberry, a considerable part of them might perhaps recover, and compensate these pains by the handsome cocoons which they would produce. At least, the result of the experiment may be worth the test.

and to the length of time that some of the wo remain' under . the pressure of too much lit Thus they gradually wither and shrink av They are for the most part removed with the li and we hardly perceive the number; but fortunat it is not very considerable. However, we ou to cleanse the shelves frequently, in order tc them of the worms attacked by this malady.

3d. The *grasserie*, equally well known by name of jaunders, is easily perceived by the bl ed condition of the worm, the circumference whose stigmata are of a citron colour, or o opaque and dirty white.* This contagious ma is sometimes as general as it is alarming. It

* "Stigmata, in natural history, are apertures in different of the bodies of insects, and of certain worms, communic with the tracheæ, or air vessels, and serving for the office o piration. Nature has given to those minute animals a larger number of tracheæ and of bronchia, than to us. A two-winged and the four-winged flies, which have a sing undivided corselet, to which their legs are all fixed, hav four stigmata in that corselet, two on each side. They them also on the rings of their body, but those on the corsel the most considerable. Of the four on the corselet, the tw terior ones are usually the largest; these, as well as the pos ones, are oblong, and placed obliquely to the length of the The colour of the stigmata often differs from that of the co Flies have beside these, several stigmata also on the ri their bodies, perhaps in every one of them. These stigma not like those of the corselet, but are round, and usually above the rest of the surface, and resembling the head of a p *Dictionary of Arts and Sciences.*

only be attributed to an abundant nourishment badly regulated; to the neglect of drying the leaves sufficiently when wet by rain or dew; and to the lack of fresh air during the last changes of the silk-worm. We must, without delay, after the discovery of this disease, lessen the quantity of food, serve to them the thin leaves of the wild mulberry, and renew the air, assisted in its circulation by a moderate, but continued fire.*

* When this malady, which my author calls contagious, spreads pretty genrally through the brood, I believe that it may be attributed principally to the confined air of the room where the worms are kept. The most fatal diseases often prevail among men confined in great numbers to a prison, though fresh air be every day admitted into their apartments. Now here are from fifty to one hundred and fifty thousand animals, which were formed to live on a particular species of the trees of the forest, restrained to enclosures in a close room, and there they must breed diseases if they be not supplied with fresh air. This note brings strongly to my memory a conversation which I formerly had, on the subject of silk-worms, with a proprietor, who then inhabited that part of Provence which now forms the department of the Mouths of the Rhone. This gentleman had a large brood of silk-worms, which in its fourth age, was so seriously and generally infected with this disease, that in utter discouragement he ordered it to be taken from the room and thrown into the yard. The next morning, without the hope of finding any melioration in the condition of the worms, but rather with the expectation of seeing the majority of them dead, he visited them, and was much surprised to discover that most of them had revived. He immediately directed the enclosures to be thoroughly cleansed and aired, and the worms to be re-conveyed to the room. They were on the first day sparingly fed, but they soon recovered their

4th. The dragee, or red disease, is not among us of ancient date. In this complaint, the complexion of the worm exhibits a reddish hue, and immediately after death the body hardens, and becomes as white as snow. Those which are assailed by this malady show black spots scattered on different parts of their skins, and we sometimes see these livid marks on the top of their heads, at the rise of their legs, and around the stigmata. This disease is more frequent in the years when the appropriate seasons are hot, and more rarely happens in those of which the seasons are temperate. It assails them when they are just ready to spin, and begin to seek the branches, when the heats are usually at their highest. At this critical time, when, by the great size of the worms, the shelves are the most crowded, this malady shows itself with the most force ; and it is always in the upper tier, where the heat and the vapours are the strongest, that the little animals are the most af-

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vigour, passed fortunately through the last change of the skin, and ultimately produced a good harvest of silk.

All the circumstances of this case prove that it is the confined air, tainted with the breath of such a multitude of these animals, which causes most of their maladies; and these very circumstances, at the same time, point to to the remedy. Though it be requisite to maintain a pretty equal and high temperature during the four first ages, yet by the establishment of a stove, the air may be frequently renewed, without any material alteration in the degrees of heat required.

flicted. Those that are the worst diseased perish on the litter, or hanging upon the branches; the others die after wholly or partly spinning their cocoons, and soon afterwards dry up. These cocoons are much lighter than the others; and although, when selected, they sell for a higher price, because the silk of which they are composed bears a greater ratio to their weight; yet still there is a loss to the seller, the increase of price being rarely in proportion to the decrease of weight.*

The remedies which we prefer to all others, in every distemper by which silk-worms are assailed, are remedies of prevention rather than of cure. They must be sought in the selection of good seed, in the methodical process of hatching, in the maintenance of a proper degree of heat, in allowing them sufficient space, in the regular distribution of food, and especially in the cleanliness of their habitation. They must not be neglected a single instant of their short career; and they require to be constantly inspected with a discerning eye, and to be tended by a ready and a skilful hand.

* The winding of the silk from the cocoons, which before the close of this work will be, I hope clearly explained to the reader, requires a complicated and somewhat expensive machine, as well as skill and practice in the proper use of it. The owners of the winding mills are therefore generally the purchasers of the cocoons from those who raise the worms.

CHAPTER XI.

OF THE CHOICE OF THE COCOONS FOR THE PRODUCTION OF SEED.

After an unpleasant narrative of the infirmities of the silk-worm, recorded in the last chapter, we resume with pleasure its natural history, and its treatment when in health; and we will now conduct it from the chrysalis to the production of the seed, and then relate minutely the manner of preserving that seed from the fatal effects of heat, and of severe frosts.

For the reasons already assigned, we wait ten or twelve days, counting from the day when the earliest silk-worms sought the branches, and then detach and collect the cocoons. A selection is forthwith made of those upon which we are to depend for good seed, and the remainder is immediately sold, or otherwise prepared for spinning. We take as many pounds of the pale flesh-coloured cocoons as we wish to have of ounces of seed. An equal number of those that are round, and of those that are pointed at both ends, must be taken, in order that an equality in the two sexes may be ob-

tained. It is important to choose those of which the chrysalides do not adhere to the interior of the envelope, and readily move when shaken; those of a good form, that are neat, heavy, and taken from the most successful shelves, and the produce of worms which have been the earliest in the different changes, and in forming the cocoon. In general, the middle-sized cocoons answer better than the large ones, because the silk-worms have not exhausted their strength in going over repeatedly so large a space, and the moth comes out from its prison with more vigour, and more celerity.*

Those among us who raise the seed of the silk-worm, place the selected cocoons upon tables, or suspend them by threads passed through a little portion of the circumference taken equi-distant from the two ends. The last method is preferable to the first, because the moth has a more solid support to enable it to make its way out of its place of confinement than it would have if the cocoon simply lay upon a table. Besides, these rows of cocoons, suspended upon transverse rods, are kept free from the dirt of the papilio, to which

* If cocoons of a middling size produced the best seed, I should not ascribe the fact to the cause above assigned. Each worm is filled with its quantum of silky matter, and must of necessity spin a length of thread proportioned to its charge. But the size of the cocoon is the result of the length of the worm, and where there is less compactness of form there is commonly less strength.

they are exposed when lying upon a table. Moreover, these moths are more readily taken, as they come out, and placed upon a bare table, to give them time to empty themselves, and a place to couple. In order to complete this union, it is, in many instances, necessary to approach the solitary male and female moths to each other. They ought not to remain united more than ten or twelve hours; and if the separation have not already taken place, they must then be disengaged. The males are thrown away, and the females are deposited upon pieces of threadbare woollen cloth, grey or red serge, or dark coloured crape.*

Towards the end of June, in our Province of Languedoc, principally from sunrise to eight or nine o'clock in the morning, the papilios come forth. The resuscitation continues during ten days. The males generally precede the females, and appear in much greater numbers on the first and second days. We must watch them, and wait for the third and fourth days, when the females will show themselves in such multitudes as to produce nearly an equality in the two sexes.

It is necessary that those who first undertake

* The colour of the cloth can be of no importance. The essential point is, as it seems to me, that it be free of nap, in order that the papilios should move upon it without obstruction, and that the eggs may be afterwards more easily detached from the cloths.

to raise silk-worms, and to produce seed for their own use, or for sale, should be taught to distinguish the male from the female moths. The first are slender, brisk, and always in motion; the females are more bulky, much heavier, and more quiet. They must also be told to suspend their files of cocoons for seed in a room more or less aired, according to the temperature of the season, with a free admission of light from the east and the south, and to convey the moths, soon after their egress, to a more obscure apartment. The male papilio lives eight days; the female lays about four hundred eggs, and in four days expires.

The double cocoons, and the *chiques*, commonly called skins, make good seed. We thus consign to an advantageous use those kinds of cocoons which yield but a small quantity of puckered silk, of which the price is always inferior to that of the other cocoons. The seed which we derive from them succeeds extremely well the first year; and beside the profit of employing these inferior cocoons for this purpose, we warrant a good product from the first trial. We do not, however, advise the repetition of this choice, unless the double and the skin cocoons were taken from another district, which would produce the benefit that results from crossing the race.

Whether we employ the good, or the less valu-

able cocoons for the production of seed, after the papilios have done laying, it must be left for some days to dry; the cloths are then to be folded up, and deposited in a dry and cool place, where they must remain six weeks. At the expiration of that time, the seed must be detached from the cloths, either with a thin piece of money, or with any other suitable instrument. We then immediately enclose it in a piece of clean linen, which we suspend during the summer heats, in a cool situation, free from moisture. At the end of August, or the beginning of September, we transfer it from the linen into a new and perfectly clean vessel, of varnished or delf-ware, and deposit it in a press, or chest, sheltered from heat, from moisture, and from severe frost.

We will now relate a singular experiment of renewal of seed, attended with peculiar success, and managed in the following manner: As soon as we are in possession of the seed, we take a small quantity of it, which we enclose in a piece of linen, clean, but softened by wear. A ligature is made five or six inches above the seed, in order that its position may be changed by shaking. We usually bring it to a hatching state by carrying it about us. On the sixth day the shell whitens, and announces the appearance of the worm on the following days. As soon, then, as the seed begins to whiten, it must be taken from the linen

and spread in a warm enclosure, and the tender leaves of the second growth must be scattered around the place of its deposit. These worms of a second production are managed in a similar manner with those of the first production, excepting as to heat, which must be maintained from ninety-seven to ninety-nine degrees. They never attain the size of those of the first hatching, and the cocoons which they form are comparatively small. They are all, however, appropriated to the producing of seed; and the same practice is followed, and the same cares given to its preservation. We now see with great pleasure that the seed arising from these small but well formed cocoons is of the greatest beauty; and we confidently assure those who are disposed to try it, that their harvest of cocoons, in the following year, will exceed one hundred and twenty pounds for each ounce of seed.* The cocoons will be very large, very firm, and of a perfect form. The silk-worms which produce them will be of an ash

* It is a subject of regret with me, that I cannot here give my reader the ratio of weight between the cocoon and the raw silk, which it yields; for without this knowledge we can make no correct estimate of the product to which this note refers. My author says not a word respecting it, and there is at the moment no document within my reach to enable me to satisfy my own curiosity, and perhaps to gratify the wishes of those who are desirous of every information relating to a topic that holds up to public view an extensive benefit to our country.

colour, glossy, and much longer than the ordinary silk-worm. Unfortunately, this race degenerates, and all its advantages disappear at the third generation; the worms become smaller, and the cocoons diminish in beauty and consistence; the quantity of silk decreases every year; the seed becomes smaller and lighter; and, at the close of the third season, they return, in every circumstance, to the ordinary class of these animals. If we then wish to reap once more those benefits, we must again have recourse to the same process; or, if we prefer a smaller, but more durable improvement in our breed, we must obtain our seed from another district, either by purchase, or in exchange for our own.

CHAPTER XII.

OF THE CHOICE OF COCOONS DESIGNED FOR THE REEL, AND OF THE DIFFERENT METHODS OF STIFLING THE CHRYSALES.

Having put aside the cocoons selected for the production of seed, in the great mass that remains there are several qualities to be distinguished, and it is necessary to sort them. The double cocoons,

the *chiques* or skins, the fine, the demi-fine and the satin cocoons, must all be separated into their proper classes. It is adviseable to set apart the double, the satin, and the skin cocoons, which produce a silk of less value, but we are fully compensated by the great price which we obtain for that yielded by the best cocoons, for being thus unmixed with threads of inferior quality, it shows all the beauty of the very best staple. Before they are brought to the reel, all these different sorts of cocoons are cleansed from the loose threads of silk by which they are surrounded, and which served to support the silk-worm when it began to form its envelope.

The fine cocoons are those of which the surface presents a very fine and very close grain.

The demi-fine are of a more loose and larger grain.

The double cocoons are those in which two or three worms have worked and enclosed themselves together. They are consequently much larger and receive the common denomination of double.

The *chiques* or skin cocoons are softer and resist much less to pressure.

As all these cocoons cannot be submitted to the reel within ten or twelve days after they are dislodged from the branches, and that this term is sufficient for the egress of the moths, it is of the utmost importance to stifle the aurelias contained

in all that cannot be wound off before the expiration of twenty-five days after the first rising of the worms to form the cocoons.

There are several methods of stifling the chrysales. They are stifled in an oven; in the vapour of boiling water; by the odour of camphire, or that of oil of turpentine; and in southern climates by exposing them to the heat of the sun.

1st. In order to stifle them in an oven, we place them about eight inches thick, in oblong baskets of osier, lined with coarse paper; and to obviate the scorching of those of the upper tier, they are also covered with a layer of paper. The heat of the oven is first raised to two hundred and ten or twelve degrees; the baskets are then put into the oven, and the oven is immediately closed. Twenty-five or thirty minutes are sufficient to kill the aurelias; and the fact is ascertained sooner or later by the cessation of the hum that arises from them, or by the effects of the vapour which they emit, and when we find that it has tarnished the colour of the cocoons to the centre of the mass, and moistened them to the softness of the chiques in their natural state. As soon as we take our osier baskets from the oven, we cover them with woollen cloths, until they are entirely cooled, and then spread the cocoons upon floors, without accumulation, in order that they may be sooner and more perfectly dried.

2d. The method of stifling by vapour from very hot, or from boiling water, is more expeditious, and is attended with fewer difficulties, than we meet with in any of the other manners. A large iron cauldron, or a brass kettle, is set in masonry, with a furnace constructed under it. We then suspend within the cauldron a hurdle of osier, or we fit to its aperture a hoop, upon the circumference of which a net is spread, or a thin piece of linen, well secured to the periphery of the hoop. When the water is nearly in a boiling state, we load the net or the linen with cocoons; we cover them with a wooden lid, the borders of which we stuff with rags, in order to confine more of the vapour, and by thus increasing its heat, to bring the operation sooner and more effectually to a close. Five or six minutes are sufficient to stifle the chrysales: the double ones require more; but it is, in every case, necessary to leave a space of eight inches between the surface of the boiling water and the net or the linen which supports the cocoons. Every six minutes the net is loaded with fresh cocoons; and in proportion as they are withdrawn, they are spread upon tables, or on hurdles, to dry; and when thoroughly dried, they are conveyed in baskets, and deposited in a place protected from dust, and from the filth of flies.

3d. In southern countries, where the heats are intense, the aurelias may be stifled by spreading

the cocoons, without being accumulated, upon sheets exposed to the meridian sun, and sheltered from the north, in order that they may receive the effects of the reverberating rays. Three hours will suffice in such an exposition when the sky is clear, and the atmosphere calm. The heat of the sun, in order to give complete success to this operation, must raise the mercury to a hundred and twenty-two degrees. At the expiration of three hours, they must be carried in the sheets on which they were spread, into the house, and be covered with woollen during twenty-four hours. The process must be repeated the next day, if there should be any doubt of the death of the chysalis.

4th. Mr. Arnaud du Buisson imagined the plan of stifling the chrysalis by subjecting it to the odour of camphire. One must place, according to him, four ounces of camphire in two parcels, in the lowest part of a case of drawers. The bottoms of the superincumbent drawers must be a network of wire, or of strong cord well stretched. Each drawer is then charged with four inches in thickness of cocoons, and the case is immediately closed, and kept so during twelve hours, after which that parcel is removed, and other masses are subjected to the same process. We ourselves have followed literally the directions of M. Arnaud du Buisson, and we have found, in the two years in which we repeated the experiment, that the slender cocoons,

or those which were collected from the hilly districts, were completely stifled; but the double ones, and all those well nourished cocoons drawn from rich plains, were not stifled. We are, therefore, fixed in our judgment of the discovery of M. Arnaud du Buisson, and we are decisively of the opinion, that camphire will not, in every case, surely cause the death of the chrysalis.

5th. A recent author has given another peculiar method of stifling the aurelia. He orders the cocoons to be put into a new cask bedaubed with oil of turpentine. The cocoons are placed in layers, and each layer is covered with leaves of paper steeped in this strong oil. The layers are thus placed in succession, and when the cask is full, it is headed up and left in that situation during ten or twelve hours, after the expiration of that time the cask is opened, and the cocoons are conveyed away and deposited in a secure place. We can neither confirm or contradict the usefulness of this discovery, never having tried it. But we believe that it is worth about as much as the experiment of the camphire. Strong odours are always adverse to the resuscitation of the chrysales, but those of the spinning trade require something more; they demand its life which never resists the heat of the oven, or the vapour of boiling water.

We have now conducted the silk-worm, step by step, from the seed to the chrysalis, and from the

chrysalis to the reproduction of the seed. We have also explained, as we hope in a clear and precise manner, the different methods of that important operation of stifling the aurelias. The precepts which we have given will perhaps obtain a little more attention from our readers, when they learn that our remarks are founded upon twenty years of application to the subject of silk-worms, and fifteen years of the most successful practice. We shall have reason to rejoice if we have contributed by our labours, to add a little to the comforts of the poorer classes of the country, and to increase the revenue of the larger proprietors. The raising of silk-worms, which is toilsome only for the space of thirty-eight or forty days, will give to both of these orders of the community many of those enjoyments of life which are so agreeable, if not absolutely needful to happiness in every rank of society.

CHAPTER XIII.

OF THE WINDING OF SILK, OR THE MANNER OF DRAWING IT FROM THE COCOONS.

The small quantity of silk which we receive from our estate, is not sufficient to give us that practical knowledge of the best methods of drawing the silk from the cocoons, and of forming it into its different denominations of thread, and to vest us with the right of imparting our own experience on this important subject to our readers as a rule of good management for them. We have therefore consulted a great many manufacturers and some authors, whose different methods we have combined, and from them we have collected the system of management, which we conceive to be the most advantageous to the general interests of France.

They all agree on one point, that silk is first manufactured under one general denomination, that of raw silk. We understand by the term of raw silk, that which is in the simple state in which it is drawn from the cocoons by means of a proper silk-mill, constructed for that purpose.

The raw silk receives several preparations which qualify it for the manufactories. It is made into organsine, into woof silk, and into a very minute thread called among us woofette.

The organsine serves to make the warp of silk stuffs. It is composed of two, three, or four threads of raw silk twisted separately, and afterwards twisted together by another wheel. This preparation gives strength and elasticity to these threads and qualifies them to obey as well as to resist the different degrees of tension to which they are liable in the loom. The organsine must be made of the fairest and finest silk, because the beauty of the texture depends almost entirely upon the beauty of the warp.

Woof silk is formed of two or three threads of raw silk, which are also submitted to the wheel and twisted together very slightly, but as they are never strained by tension in the loom, these threads are never separately twisted.

Sometimes the woof silk is made of a single thread of raw silk lightly twisted; and this preparation passes with us under the denominations of woofette and of hair-silk.

Of these three kinds of silk, employed in the manufactories, the organsine is the most valuable. It sells for a much higher price than the two other species, not only because it is composed of the

best materials, but because it is wrought with more labour and more care.

There are but few persons in France who have the art of making organsine; we are therefore obliged to import by far the greatest part of that which is wanted by our manufacturers. More than fifteen millions of silk are made every year in France; and for the support of our looms, we are obliged to draw as much more from foreign countries.* The chief portion of this costly importation is organsine silk. We obtain it from Piedmont, because the Piedmontese manufacture it best, and because they are the only people in Europe who know how to make it well. All the northern States, where there are manufactories of silk, are forced, like ourselves, to have recourse to them for the warp of their stuffs. This quality of silk, so well worked, and so well prepared for its purposes by the Piedmontese, secures to them an ample remuneration for their labour, and lays us all under

* In this case the version is literal. My author says, "*La France fait chaque annee plus de quinze millions de soie,*" and not pour quinze, &c. This is not explicit, for he leaves us to reason on the subject when he ought to have obliged us to comprehend his meaning at the first glance. A little reflection, however, enables us to discover that he does not intend to apply the millions to so many pounds of silk, because the value of the importation of the raw material would then be too enormous, but to the cost of the silk in livres; and this estimate appears to me full small enough.

an increasing tribute to them, proportioned to the growing state of silk manufactures in France, and in many other parts of Europe.

Whether we wish to make organsine, woof silk, or hair silk, it is indispensably requisite that we be acquainted with the best manner of making raw silk; for those three kinds are only raw silk variously prepared. On the perfection of this first operation principally depends the goodness of the three others; and it is mainly from their skill in winding the thread from the cocoon, and the perfection of their machinery, that the Piedmontese have the advantage of us in the manufacture of organsine silk. As the quality of their raw silk is perfect, they well know that it is more beneficial to them to convert it into organsine, than into woof silk. If taught by their good example, we perfected our machinery and improved our skill, the value of our silk would be enhanced more than one third.

It is, then, peculiarly from the manner of winding the thread from the cocoons, that depends the profit which the State derives from the raising of silk-worms. Though we may know how to cultivate the mulberry, and to take care of the worms till we possess the cocoons, all our cares are nearly lost, if we bungle through the winding process.

CHAPTER XIV.

OF SEVERAL MACHINES INVENTED TO MAKE THE WINDING PROCESS MORE PERFECT.

The mill which the French commonly use to draw the silk from the cocoons, is composed of the frame *A B C D*, *plate II.* which is called the bench of the mill. The length of this frame is about five feet five inches, and its breadth two feet two inches. The part *A D*, is called the fore part, and *B C*, the back part of the mill. The bench of the mill is supported by four legs, which are connected underneath like the legs of a table. The legs of the fore part are twenty-six inches in height; those of the back part are thirty-two and a half. The whole frame must be put together in the most compact and substantial manner. Upon the back part of the mill is a reel of two feet two inches diameter. The axle-tree, *E F*, of this reel, is furnished at the two ends with two iron ~~points~~ pivots, which rest upon the two props *G* and *H*. The reel is turned upon the props by means of the handle *a b c*, which is also of iron. On the fore part of

the frame there are two rods of iron, *a* and *a*, which are placed horizontally in the traverse *A D*, at six inches and a half apart. These two rods are called the wire-drawers, because their extremities, *a* and *a*, are bent in the form of a wire-drawing iron, and through them must be passed the two threads of silk. We now give to these rods the improved form of a cork-screw, because that shape facilitates the means of placing and of removing the threads of silk at will, without being obliged to break them, as was the case when these rods terminated in the form of a ring.

At about nineteen inches from the traverse *A D*, is a wooden ruler, *d L*, which rests one of its extremities on the prop *L*, and the other is fastened to the pulley *c* in the manner which we shall explain. This ruler, perhaps on account of its form, is called the sword; it has also obtained, from its motion, the name *va-et-vient*. This sword, or *distributing-rod*,* bears two small rods of iron, *m* and *n*, of four to five inches in length, which are set perpendicularly, at six inches and a half from each other. The ends of them are likewise made of a spiral form, in order that there may be no difficulty in passing and repassing the threads of silk. These two iron rods are called the guides, because

* I have introduced here the name of the distributing-rod, as more appropriate, and have used that appellation through the remainder of the treatise.

it is by their agency that the threads are conducted, and properly distributed on the reel.

The prop *L* must be open on the top, in order to give a passage to the distributing-rod; and the notch ought to be sufficiently wide and smooth to permit the rod to act freely in its motions forwards and backwards.

The pulley, *f*, is called the little roller. It is placed horizontally, and turns upon a pivot, which is firmly secured in the side *A B* of the frame. There is strongly fixed upon the little roller a piece of iron, *d f*, of which the end is bent to form a pivot, that passes through a hole in the extremity of the distributing rod, at *d*, and serves as the point of its support, and the centre of its motion. This pivot must not be closely fitted to the hole of the rod, but, on the contrary, must be sufficiently loose to allow of a free movement.

The axletree of the reel is rounded at its extremity *E*, where there is a channel that enables it to perform the office of a pulley. From this channel proceeds a cord-without-end, which encircles the little roller, and communicates to it the motion of the reel. The roller being thus brought into action, the pivot *d f*, which is fixed to it, makes the distributing rod to move alternately from right to left, and from left to right: that is, from *d* to *L*, and from *L* to *d*. It is this alternate

motion which has given the name of *go-come* to the ruler that bears the guides.

In the fore part of the mill, in front of the traverse *A D*, is a basin *l m n*, usually of copper, of an oval form, set upon a furnace *o p q*. The furnace and the boiler must be so adjusted that the two wire-drawers *a a*, shall be raised about ten or twelve inches above the borders of the kettle, and that they correspond perpendicularly to the middle of that vessel.

The furnace may be made of tiles, of bricks, of iron, in fine of a variety of materials; but of whatever it be made, there must be a small door at *p*, for the purpose of maintaining a fire during the time of drawing the silk from the cocoons. On the left side, that opposite to the door, a small chimney or a tube must be fixed to carry off the smoke. The brazen kettle ought not to be very large, or very deep, but it is necessary that it be so well fitted to the furnace, that no smoke or hot blasts can escape to burn or to discolour the silk, and to incommode the Drawer.*

Upon the fore part of the mill, between the traverse *A D*, and the other traverse *Y Z*, there is a plained board nailed underneath which is called the shelf, and serves the Drawer as a place to de-

* The dimensions of this basin may be from twenty to twenty-four inches in length, sixteen to eighteen inches in width, and four to five in depth.

posite her bunch of twigs, her cup of fresh water to cool her fingers, and the bad cocoons that do not wind.

The reel, which requires to be of an ingenious mechanism, is composed of an axletree and four arms. The axletree, as we have already said, is armed at each end with a pivot of iron, supported by the two props *G* and *H*, and is turned by means of the iron handle *a b c*. This axletree is pierced by four mortises, which traverse it in the form of a cross, to receive the spokes of the arms.

The arms are composed each one of a traverse *g h*, and the two spokes *r s* and *t v*. These spokes support the traverse at one end, and they enter by the other into the mortises of the axletree. The mechanism of these arms demands much attention. It is of the utmost consequence that they be correctly made; we should not otherwise be able to take the skeins from the reel without spoiling the silk. In drawing the silk from the cocoons we always make two skeins at a time; one at one end of the traverses, and another at the other end. These traverses thus simply constructed would not give way in any manner to facilitate the removal of the skeins. Now as the silk is full of gum, in cooling it becomes glued to the traverses, and this increases the difficulty of its removal. The rapid motion of the reel keeps the threads of silk in continual tension, and they

become more tight upon the reel by the contraction of the silk as it dries. All these circumstances make it very difficult to take off the skeins from the reel. By a particular construction of the arms of the reel, we obviate every impediment. This construction consists in making the spokes of two of the opposite arms of one piece, and the spokes of the two other arms of separate pieces. The spokes which are of one piece traverse the axletree of the reel, whilst the spokes which are of two pieces, do not go through the axletree but terminate in the mortises upon the spokes that are of one entire piece.

In the figure, plate second, the spokes of the arm which are seen above the axletree of the reel, and those of the opposite arm underneath, are of one single piece, and pass through the axletree in the mortises 2 and 3. But the spokes of the two arms which are perceived on the right and reft, and that appear to go through the axletree, are of two distinct pieces, terminating in the mortises *s* and *x*, upon the spokes of the two other arms. We never displace the two arms which are supported by the spokes of a single piece, and one of the intersected ones is likewise not to be dismounted: they must on the contrary, all the three, be firmly secured in the mortises of the axle. Without this precaution, the rapid motion of the reel would cause the

intersected arm to escape from its place like a stone from a sling.

With regard to the other intersected arm, marked in the figure by the letters *s r t v*, it is moveable, that is to say, that one may dismount it, or restore it to a firm position at will by the means of two wedges of wood. The mortises *s* and *x*, designed to receive the divided spokes, are made longer than the mortises 2 and 3 of the undivided spokes. When we wish to fix this arm upon the reel, we force the two spokes into the two mortises exactly opposite to the spokes of the other arm. As these spokes do not fill the whole length of the mortises, we drive, by smart strokes of a hammer, the wedge *y* into the mortise *x*, and a similar wedge into the mortise *s*. These two wedges, pressing strongly the ends of the spokes in the mortises, hold them steadily, so that with the quickest motion of the reel they cannot escape.

When it becomes necessary to slacken the reel, in order to remove the skeins, we take out the wedges and thrust the spokes into their places, that is to say into the other end of the mortises, where they sink by their own weight into the axle as much as is necessary, because the mortise in this particular part pierces through the axle-tree. Proportionably as the spokes sink in the mortises in the place of the wedges, the traverse

g h, is drawn nearer to the axle, and the skeins are then found slack enough to be taken with ease from the reel.

All the different parts of the reel are commonly made of walnut wood. Every other part of the mill may be made of white oak, or of any other wood that is well seasoned, and that is not very liable to be affected by a moist atmosphere.

For the instruction of those who may undertake to construct a winding-mill, we will further remark; 1st. That a small cut must be made obliquely in the undivided spokes at the point where they meet with the wedges in the mortises. This is necessary in order to give the wedges a better hold of the divided spokes and thus confine them immoveably.

2d. That part of the mortise which receives the wedge, we here again direct to be made longer and wider than the part occupied by the divided spoke for the purpose of admitting the spoke to sink readily when we loosen the reel.

3d. The spokes of the moveable arm ought to have a little play at the points *r* and *t*, in order that they may yield in some measure when the lower ends are driven by strokes of the mallet, into the place of the wedges.

4th. The silk when it reaches the reel is yet full of gum, which the hot water of the basin has liquified, and it therefore readily becomes

glued upon the traverses of the arms. This is a great disadvantage, because in taking the skeins from the reel, the adhesion gives a roughness to the silk. The remedy which has hitherto been applied to this inconveniency, has consisted in the diminution of the surfaces upon which the threads are extended. To attain this object, we cut a groove in the external part of each traverse, following its whole length, and leaving borders less than the tenth of an inch thick, and wrought perfectly smooth. By this mean, the threads of silk bear upon the two borders of the channel, and touch scarcely more than two points of each traverse.

5th. The arms of the reel ought not to be fixed upon the axletree, at equal distances from the two ends, but more space must be left on the side of the pulley, in order to reserve a free passage to the cord-without-end.

The ancient mill which we have described, is the basis of all the others, which differ from this only in a small number of pieces that have been added or altered to bring it nearer to perfection. All the other pieces are entirely similar both in form and in dimensions. In every mill for winding silk we find again the reel, the distributing rod, the guides, the shelf, the kettle, the furnace, the supporters of the distributing-rod and those of the axle. No change has taken place in any

of these pieces; they are all of their original form, and continue to be applied to the uses for which they were first invented, and to which they still seem to be well adapted. The little roller and the pulley of the axletree of the reel are the only pieces that have undergone some changes. Upon these two pieces depends the perfection of the winding-mill; and it is also with regard to these two pieces that artists have exercised their invention and their industry.

CHAPTER XV.

OF THE DEFECTS OF THE ANCIENT MILL FOR WINDING THE SILK FROM THE COCOONS, AND PARTICULARLY OF THAT BLEMISH CALLED GLAZING.

The ancient winding-mill, which we have described in the preceding chapter, is a machine passibly complex, when we take into view the simple purpose for which it was first intended; and were we to estimate its adaption to the design, by the accuracy observed in the construction of the different pieces of which it is composed, one would be apt to believe that nothing

could be added for its improvement. Nevertheless, it is a very imperfect machine which makes only a defective and homely silk. Notwithstanding the imperfections of this ancient mill, it is still that which is mostly used in France. The French nation, otherwise so active and so industrious, has in this first process of making raw silk, remained for nearly one hundred and fifty years attached to the same bad, inveterate custom. This does not appear surprising to us, because we know that these operations have continued in the hands of country people, who having once contracted a bad habit, and being rarely capable of correcting themselves, are generally but little disposed to receive instruction from others.*

The principal failing of this winding-mill, is that it produces a glazed silk. As this term may not be well understood by many of our readers, we will define it. Glazing consists in the threads of silk being so badly directed upon the reel, that

* These severe remarks, of pretty general application to the rural population of France, fall harmless here among the enlightened yeomanry of our country; for many of them have contributed to the advancement of knowledge, and most of them have that portion of good sense which enables a man to abandon erroneous habits and to receive those improvements which the experience of others has established. I therefore pray their forbearance in favour of my author; and I hope, notwithstanding the above sally, that they will, in perfect good humour, accompany him to the end of his journey.

they lay upon each other. As they are full of dissolved gum, and touch each other in their whole length, they become glued together, and the gum, when dry, gives that glossy appearance to the skeins, which we call glazing.

One of the most perplexing casualties in winding the silk from the cocoons, is the glazing, of which we enumerate several different sorts. Although they be not equally bad, they are sufficiently so to make the silk lose a part of that glossiness which constitutes its good quality, and consequently they diminish its value. In effect, when we come to wind these glazed skeins upon the quills, the threads are found to be so strongly glued together, that the minute particles of which they are composed break in many places, and the separation of its fibres cottons the silk, and renders it unfit to be converted into organsine for the warp of our best silk stuffs.

Before the pulley, the distributing rod, and the guides were added to the ancient mill, the skeins were completely glazed; they were masses of silk, of which all the threads cohered throughout their extension; because falling continually in the same direction upon the reel, they touched each other, from the beginning to the end. The cultivators of silk, feeling all the disadvantages of this blemish, sought its remedy in a winding machine, which would change continually the position of the

threads upon the reel, and thus prevent, for a certain number of revolutions, their application upon each other. They first imagined to cause the threads of silk to pass through two guides of iron, fixed in a distributing-rod of wood, and to give to this distributing-rod an alternate motion from right to left, and from left to right. In order to produce this movement, they secured it by one end to the pulley *f*, (Plate II.) and rested the other end upon the prop *L*, in the manner already explained. The pulley receiving its movement from the axle of the reel, gives a rotary motion to the pivot *d f*, that carries with it the end of the distributing-rod, and communicates to it a forward and a backward movement. As the threads of silk are passed through the ringlets of the two guides, and these guides are set upon the distributing-rod, it is evident that they also are carried from right to left, and from left to right. Consequently, the threads will not always fall upon the same points of the reel.

Such, then, is the important use of the pulley, of the distributing-rod, and of the guides. Their design is to obviate the glazing; or, which amounts to the same thing, to prevent the threads from falling upon each other. It is, therefore, required that the movement of the pulley be so proportioned to each revolution of the reel, as to produce the most advantageous distribution of the silk upon the reel. When we perceive that there

is some glazing in the skeins, we may at once conclude that the proportion between the pulley and the grooves of the axle is defective.

If we suppress the pulley and the guides, that the threads might go straight from the wire-drawers to the reel, unquestionably these threads would constantly fall upon the same points of the traverses, and both the skeins would be completely glazed as in figure 1st, Plate III.

If in making use of the pulley, it were made of the same dimensions as the channel of the axle, it would make precisely the same number of revolutions as the reel, and the two skeins would still be entirely glazed, but they would be placed obliquely and in the manner of a scarf upon the reel. (See figure 2.)

But if the reel should perform two revolutions whilst the pulley made but one, each skein would be divided into two parts, crossing each other at the same point, as in figure 3.

If the pulley made one revolution in the same time that the reel performed three, each skein would appear to be separated into three bodies, and would cross in two points, as represented in figure 4.

The pulley making one rotation whilst the reel would make four, the two skeins would each of them be divided into four parts which would cross in three points. This glazing is represented in figure 5.

It is, then, easy to conceive that, as the relative movements of the pulley and of the reel are variously modified, the skeins will be placed upon the reel in an equal variety of forms, and consequently, that the greater or less degree of glazing will depend upon the good or bad ratio established between these two pieces. The above mentioned diversities of glazing arise from the defective proportion between the pulley and the grooves of the axle of the reel. This imperfect proportion produces in the above cases a distribution of the threads upon the traverses, which from one to six revolutions return in the same order to the same points; and the gum being still in a liquid state, they are inevitably glued together.

It would be useless to enumerate here, all the erroneous proportions which have been in use among us, but it will better promote one of our chief designs in writing this treatise, to make known the late principal improvements, and to urge the abandonment of our blundering habits, and the adoption of a more perfect system.

There are three proportions that have been proved to be very good, although they have not the same degree of excellence. For instance, the ratio of twenty-three parts for the circumference of the grooves of the axle, and of thirty-seven parts for the circumference of the pulley, places the threads on thirty-seven different points

of the reel, before they return to the first course of threads laïd.

The proportion of twenty-nine of the axle, to forty-seven of the pulley, distributes the threads on forty-seven different points, and makes a skein almost without glazing, and nearly as perfect as that represented in figure 7, Plate III.

The ratio of 22 1-2 to 37, appears at the first view preferable to the two others, because the thread does not return to the first thread laid till after seventy-four revolutions. But the approximations are so close that there is danger of glazing. We believe then that the two first proportions present the most advantageous results.

It appears to be very easy to establish a good proportion between the pulley and the grooves of the reel. We attain nevertheless with great difficulty the requisite ratio. Every one, after reading the two following instances, taken from a publication of the author of the corrected winding-mill of Languedoc, will be able to judge of the extreme perplexity of fixing immoveably that just ratio which will secure our silk from the detriment of glazing.

That ingenious author states, "that if the pulley is to the axle as 29 to 47, that is to say, if the axle make 47 rotations whilst the pulley makes 29, one will have an excellent proportion, and the skein formed from it will be perfect, and nearly

such as is represented in figure 7, Plate III. But so much accuracy is requisite, that if this same pulley, instead of 29 precise revolutions, should make merely a quarter of a revolution more or less, the whole proportion would be discomposed, and would produce in the skeins a difference resembling that in figure 6, Plate III. Now one-twentieth of an inch, more or less, in the circumference, suffices to work these unaccountable changes."

The author urges his proof still further, and to make one more sensible of the exact proportion which it is necessary to establish between the axle and the pulley, he adds: "Let us suppose that the three lines *s t* and *u*, (on the margin of Plate III.) be three threads which measure exactly the circumference of three different grooves of axles; the difference of length between them must appear to be quite unimportant. Nevertheless, when applied to a pulley of twelve inches in circumference, they will cause a very different distribution of the thread upon the reel. The longest, *s*, will place the thread in twenty-one separate points; the middle one in forty-seven, and the shortest in thirteen. Compare the three numbers together; compare the three measures with each other, and then imagine the extreme accuracy required in adjusting the proportion between the periphery of these two pieces."

We must then conclude with the author of the above statement, that it is extremely difficult to establish, between the axle and the pulley, a ratio that will not fall upon one of the innumerable faulty points. Even when the machinist perfectly understands this proportion, and should succeed in executing it with the greatest exactness, there would still remain many difficulties to surmount in order to avoid the blemish of glazing. These difficulties arise from the general defects of the winding-mill itself; for this machine, by the changes to which it is liable, is defective in almost all the pieces of which it is composed. The roller has its failings; the pulley of the axle has its own. The same may be said of the distributing-rod. The cord-without-end is liable to alterations against which it is impossible to guard it, and to which it is difficult to apply a perfect remedy. In fine the whole structure of the winding-mill very often occasions glazings, as we shall proceed to explain in detail.

The roller and the axle of the reel are of wood; fogs, rainy or moist weather make them swell; dry weather, northerly winds, and heat contract them; and in either case, the proportion between the two is discomposed.

If the Drawer, who collects the threads from the kettle, in presenting them to the Winder, lets some drops of water fall upon the roller, the wood

will swell, and thus the circumference of this pulley being increased, the roller loses the proportion which it bore to the pulley of the axle. The water will also swell the pin that serves as a pivot to the roller, and will contract the hole into which this pivot enters; therefore the roller must turn with more difficulty, and will make fewer rotations than the number required to maintain a proper ratio with the movement of the reel.

If, whilst we are drawing the threads from the cocoons, some particles of silk should adhere to the groove of the roller, or to that of the pulley of the axle, the circumference will be changed, and the requisite proportion be destroyed. Or if some of those particles should attach themselves to the axle of the roller, they would embarrass its motion, and it would turn with more difficulty.

The distributing-rod not turning freely at its centre of motion upon the pivot, (*d*, Plate II.) the roller would be restrained in its movement, and the full number of revolutions would not be performed; or if the pivot *d f*, which fastens the distributing-rod to the roller, not being strongly fixed, should have the least vibration, in both these cases the ratio would be discomposed, and the glazing would be inevitable.

If the iron rods of which the guides are formed should be too long or too slender, the alternate movements of the distributing-rod would give them

oscillations that would certainly produce the glazing.

The cord-without-end, by its continual friction, gradually wears away the wood of the roller, and that of the pulley of the axle, and by thus deepening the channels, causes an irregularity in the just proportion which ought to exist between them.

If the cord be too loose, it will slip upon the axle or upon the roller, and in either case the roller will not make its proportional number of rotations.

A cord of cat-gut lengthens, and consequently slackens, in moist weather, and it shortens and becomes tighter, when the atmosphere is dry. If the cord be of hemp, or of flax, the effect is reversed; it shortens in moist, and lengthens in dry weather. Thus every change in the state of the air produces a change in the tension of the cord.

If the pivots of the axle of the reel be not precisely in the centre of the pulley, the reel will not turn in a perfect circle, and the cord at each revolution will be alternately tight and loose. This is with us a very common defect. It arises from the inattention of the machinist in making the channels of the axle before the pivots were set; whereas these pivots ought first to be secured in their places, and serve as the centre of motion in forming the channels.

The horizontal position of the roller upon the frame of the mill, and the vertical situation of the

pulley of the axle, make the cord-without-end to enter obliquely into the cavities of these two pulleys. The channels are usually formed in half circles; and the lowest part having a smaller circumference than the sides, the cord entering indirectly, bears partly upon the sides; and therefore, at each revolution of the reel, runs over an intermediate space between the bottoms and the uppermost parts of the grooves. If a slow motion be given to the reel, the cord, being then less tightened, slides more easily to the bottoms of the channels, and the proper ratio is preserved; but if the reel be turned swiftly, the cord is more tightly stretched, and supports itself rather upon the sides. The space passed over by the cord is consequently greater or smaller, according to the slowness or the quickness of the movement, and therefore may alter the proportion, and produce the glazing.

We have, indeed, for a long time past, taken notice of this variation in drawing the silk from the cocoons. We have always remarked that, in changing the Winder, there was a change in the form of the skeins, and we attributed this variation merely to the change of hand, because we did not seek for the true source of the evil. The author of the corrected winding-mill of Languedoc was the first to disclose the cause of this variation.

If the structure of the winding-mill be not executed in the firmest manner, the vibrations to

which it would be liable, would infallibly show some degree of glazing. The same thing must occur if the axle be not so well adjusted between the two props, as to prevent it from moving either on one side towards the handle, or on the other towards the prop *G*.*

CHAPTER XVI.

DESCRIPTION OF THE WINDING MILL USED IN PIEDMONT.

Those who know by experience what glazing is, who are acquainted with its different kinds, and

* My author has, in the preceding chapter, and in this, very properly recorded the importance, and given the rules of constructing the winding-mill in a solid and correct manner; and to show the dangers of glazing, with the great difficulty of escaping them all, he has there with equal propriety also given us a particular account of the different causes of that blemish. He describes its production in so many various ways, in order to awaken public attention, and to give to his fellow-countrymen a full perception of the disadvantages under which they laboured by their culpable heedlessness of this momentous subject. The value as well as the beauty of silk is greatly enhanced by avoiding that defect; and he, like a good citizen, was anxious that his country should be relieved from the charge of supporting the labourers of a foreign nation, by employing its own artisans in working an improved production of its own soil.

the multiplicity of causes which produce them, were sensible of the extreme difficulty of banishing entirely this evil from the process of forming the silk into skeins. To attain that end, it would be requisite to have winding-mills executed with mathematical accuracy. There can be no hope of this as long as the construction of those mills is left to country workmen. These unskilful artists do not see the marvellous effects of preciseness in the adaptation of the different parts of this useful machine. They know nothing of the proportions upon which the perfection of the winding-mill depends. Their mills, grossly constructed, without the aid of rules, or of any thing like principles, make only a bad and unsightly silk.

It would be a lasting benefit to our country, if in every province whose inhabitants are engaged in raising silk-worms, there were established a manufacture of winding-mills, directed by an intelligent and scientific man; and that by a strict law, no machine should be delivered to a purchaser without having been previously examined, piece after piece, by the Director of the manufactory; that a statute, under a heavy penalty, should restrict every one to the purchase of his mill from the authorized manufacture of the Province; or, if made elsewhere, that it should pass inspection, and receive the certificate of the Provincial Director before delivery. By patronizing such an esta-

blishment, the French would soon succeed in making a silk as beautiful, and perhaps more perfect, than that of the Piedmontese.

No nation of Europe has contributed so much as the Piedmontese, to improve the mill for the winding of silk; but this machine did not at once reach the perfection which it has now attained. One of the principal points which first drew the attention of their cultivators of silk, was that the fibres, of which the threads were composed, reached the reel without being embodied, or united to each other. As a remedy to this defect they first imagined to cause each thread of silk, as it issued from the wire-drawers, to pass over the circumference of two cylinders. This invention had two advantages: the one was, that the different fibres of which the threads were formed, being compressed upon the cylinders, the liquid gum with which they were saturated glued them together, and made of the whole a single compact thread: the other advantage was, that the compression upon the cylinders expelled the moisture, and caused the threads to be placed upon the reel in a dryer state, and less liable to form glazed skeins. The cylinders which they used at that time were merely two common spools, through which two iron pins were passed, as they are represented at *P* and *O*, in the figure *R*, placed under the reel, Plate II. This figure *R* represents a frame of wood support-

ing the two spools. The two tenons, 6 and 7, were driven into the two mortises 4 and 5, of the traverse *A* and *D*, and each thread of silk was passed around one of these spools.

This new method at first took favour, because it gave to the silk a finished appearance, which it never had before. But this invention had also its disadvantages. The pressure upon the spools gave a flat formation to the threads. Besides, this pressure was not strong enough, for the fibres were not completely united ; were not sufficiently dry ; were not sufficiently smooth. For these reasons they suppressed the spools, and they imagined to cross the two threads of silk issuing from the wire-drawers, as represented at the point *x*, Plate IV.

This innovation succeeded admirably well. The silk acquired from that moment a very different and a far superior quality. From the flat thread of the spools, it became round on leaving the point of crossing. Although the threads were only applied one upon the other, without being twisted, the fibres appeared to be well united, and to form a compact thread.* This crossing of the threads expelled also the moisture much better than the

* I believe that M. De la Brousse was here led into an error by misinformation. The mere application of one thread upon the other, if the pressure were considerable, might cause the close union of the fibres, but I do not see the possibility of its producing roundness without a single convolution.

spools. It stopped, likewise, the floating particles of silk which arose from the caldron with the threads. The silk was thus distributed upon the reel in a purer and in a dryer condition.

After the discovery of the crossing, the Piedmontese added several other improvements to their winding-mill. They applied themselves more especially to the correction of the defects of the distributing-rod and its guides; and to the study of establishing between the roller and the pulley of the axle, a proportion so exact, that the threads should continually take a separate position upon the traverses of the reel; so that no longer laying upon each other, they might not be glued together. After the most careful examination, they concluded that they should never attain the end which they sought, as long as the roller should receive its movement from the reel, by the mean of a cord-without-end; because this cord, by the alternate changes to which it was liable, and which were constantly occurring, conformably to the different degrees of moisture or dryness of the atmosphere, perpetually deranged the most perfect proportion established between the axle and the roller. They have prohibited the movement by the agency of a cord, and have substituted four gearing wheels, with an established number of teeth, in order that the advancing and the retiring motion of the distributing-

rod with its guides, should be permanently regulated with each revolution of the reel.

The Piedmontese have also increased the distance from the guides to the reel, and have fixed it at three feet five inches, in order that the minute particles of water with which the threads of silk are charged, being longer exposed to the air, might evaporate more, and the silk be deposed upon the reel in a dryer state. All these rules, and several others relative to the winding of silk from the cocoons, are comprised in a statute, which the Government of Sardinia causes to be rigidly observed.

In the winding-mill established by law in Piedmont, the roller and the pulley of the axle are perfect cog-wheels. From one to the other of these pulleys, there is an arbre three feet* long, which at each extremity is armed with a pinion-wheel. One of these pinions gears with the pulley of the reel, the other gears with the roller; it is by these means that the roller receives motion from the reel.

As to the proportion, they probably chose that which they considered to be the least imperfect, and it was between the pulleys of the reel and of the roller that it was established. The two pinions of the arbre had each the same number of teeth as the pulley of the reel. If the pulley of the axle had twenty-nine teeth, and the roller forty-

* This is French measure, equal to about 3 feet, 2 1-2 inches.

seven, they had the same ratio as that adopted for the improved winding-mill of Languedoc.

Although the winding machine of Piedmont have passed, till now, for the best mill in use, it is perhaps not the one which ought to be preferred. The four gearing wheels being made of wood, are liable to many casualities. The teeth wear away and are subject to break; the arbre, which communicates the movement to the distributing-rod, being also of wood, is apt to warp, and is exposed to vascillations on account of its length; so that they are under the necessity of providing two or three sets of all these pieces, in order to change them in case of accident. This provision occasions also an increase of expense.*

* We find here the general construction of the Piedmontese mill, but not a word of information respecting the ratio of motion. Probably it was not then known in France, for that was a point which could not be ascertained like the other parts of the machine, by a transient inspection; and it was of importance to guard the secret. But the great difficulty does not consist so much in finding a good proportion between the pulley of the reel and that of the roller, as in meeting the alterations which may occur in that proportion, from a variety of causes. The Piedmontese mill must be constructed upon better principles, or with more mathematical preciseness than all others, or their artizans must operate with superior skill, otherwise the silk which it produces would not to this day have continued to surpass in beauty and excellence that of the rest of the world. As to the extra charge of providing a change of pieces, the cost is of little importance when the advantage resulting from it is so great. A machine of this kind ought not to be left in the

CHAPTER XVII.

DESCRIPTION OF THE IMPROVED WINDING-MILL OF LANGUEDOC.

There are in this new winding-mill three improved pieces, and three additional pieces. The three improved pieces are the pulley of the axle, the roller, and the distributing-rod. The three additional pieces are a moving traverse which bears the roller and the distributing-rod; a pulley with its bracket, and a cord provided with a weight of six or seven pounds.

The pulley of the axle is no longer, in this new mill, as it was in the ancient one, a simple channel cut around the end of the axle. It is now a real pulley made in the same manner as the roller, but of much smaller dimension. The inventor calls this the joint-pulley, because it is closely jointed to the end of the axle-tree at *E*, Plate IV. where

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case of stopping for the lack of a spare piece to replace one that may have failed. If in their improved mill of Languedoc they neglected a supply of pieces to put in the places of those that perform badly, the Piedmontese may well laugh at their improvidence.

it is well secured with glue in order that they may form one body.

The figure *A* of the same Plate, represents this joint-pulley seen in front, and the figure *B* shows its profile. There is a perforation of two inches and one sixth of an inch in diameter, through its centre, to which the end of the axletree is fitted so as to fill it exactly, and to admit of its being solidly fixed by glue. The author requires that the end of the axle be not rounded off for the reception of the joint-pulley, until the reel, armed with its two iron pivots, be in place. By turning the reel after it is placed upon the frame, an artist, with his chisel, may be sure of taking off the wood at an equal distance from the centre, and thus the pivot of the axle would also be in complete accordance with the centre of the pulley; it would, therefore, turn in a perfect circle with the reel, without which the proper ratio of motion could not be maintained. The bottom of the channel of this pulley is furnished in its whole circumference with twenty-three polished iron pins, driven tightly into the holes. The openings of them are seen marked in the figure *A*, and the pins in their places in the figure *B*, Plate IV.

It will be remarked, at the first inspection of Plate IV. that the inventor has not left the handle of the reel on the side of the pulley. He has removed it to the other end of the axletree, as may

be seen at *M*, and this is a beneficial improvement.

The roller is of the same form as the pulley of the axle; but its diameter is greater, and the central hole is much smaller, being only seven-tenths of an inch in diameter. The circumference of this pulley surpassing considerably that of the joint-pulley, the iron pins with which the bottom of its channel is provided are more numerous; they amount to thirty-seven. The joint-pulley is three inches and eight-tenths of an inch in diameter; and the diameter of the roller is nearly six inches. One may give more or less depth to the channel of each of these pulleys; but the proportion which the author has established between the periphery of the pins of each of them must be strictly followed.

This proportion is of twenty-nine parts for the circumference of the axle-pulley, and of forty-seven parts for that of the roller. By this arrangement the reel makes forty-seven rotations, whilst the roller makes only twenty-nine. This proportion is excellent; but we must recollect that it is to be cast upon the dimensions of the circles of iron pins of each pulley. The accuracy depends upon the mathematical arrangement of these pins, because the cord-without-end must bear upon them.

As the author of this improvement had no

reason to believe that the artisans who make the pulleys of our winding-mills could work with a precision sufficient to secure that exact proportion which he had established between the roller and the pulley of the axletree, he had at first imagined to form upon the roller three channels of different depths; so that these channels being in distinct proportions with the joint-pulley, the roller by this mean became equivalent to three. When some derangement in the proportion was discovered, that is to say, as soon as any glazing was perceived upon the skeins, the cord-without-end was removed to another channel; thus the proportion being changed, one might presently remark that the distribution of the silk was made in a different manner upon the reel. If, a few minutes afterwards it was perceived that this new proportion exhibited a bad effect, the channel was immediately changed either by removing the cord-without-end to the third, or by restoring it to the first channel.

To have obtained this remedy against the glazing, was a point of considerable importance; but it was attended by two disadvantages. The one was, that the cord-without-end could not be removed from one channel to the other without stopping the reel and interrupting the winding operation; the other was, that the roller was rendered too heavy by the introduction of the three

channels upon its circumference. It was necessary to increase its thickness, and this thickness made it unwieldy, whereas the roller cannot be made too light, in order to yield readily to the impressions of the cord-without-end.

The author felt better than any body what was wanting to his new invention, and he immediately sought a remedy. He has succeeded by the most simple, and perhaps the most efficacious means that it is possible to imagine. It consists in placing one or both of two iron pins, as the case may require, in two holes made for this purpose in the roller, and its effect is wonderful. We can never use one or the other of these two pins without producing a total change in the appearance of the skeins. All this arises from the simple act of placing or removing one of these pins, whereby the periphery of the roller is increased or diminished about a hundred and fiftieth part. That small variation suffices to break off the imperfect proportion.

The figure *C*, Plate IV. represents the front of the roller, and the figure *D* shows its profile. The points which form a circle near the circumference of the roller, mark the holes of the thirty-seven iron pins which occupy the bottom of the channel; and in figure *D*, we see the arrangement of these pins in their places.

The two little iron pins *f* and *f*, marked in the

figure *C*, Plate IV. are the two substitutes in lieu of the two grooves suppressed by the author of the improved winding-mill of Languedoc. They are tied at their heads by a small piece of packthread, which is nailed upon the face of the roller at the point *g*. Between the circle of black marks, indicating the holes for the thirty-seven iron pins, and the exterior border of the roller, we see two holes, *t* and *u*, designed to receive the two pins. As these holes are, in a slight degree, more distant from the centre of the roller than those which occupy the bottom of the channel, the introduction of one of these extra pins must increase the periphery of the roller, and necessarily change the proportion subsisting between that and the pulley of the axle.

When the two little pins are not wanted to break up some imperfect proportion, they must be thrust into two holes, *h* and *i*, made expressly, and marked by a black point on each side of the nail that secures the packthread. This precaution is taken in order that the pins may cause no embarrassment upon the roller, and produce no obstacle to the movements of the distributing-rod.

The iron guides were formerly made of four, five and six inches in length. The ingenious author of this mill has reduced them to an inch and a half, the screw itself included.

He has also added to his improvements the

moving traverse. The axis of the roller was before his alteration sunk into the frame of the mill on the side *A B*, Plate II. and the prop *L*, which supports the other end of the distributing-rod, was also sunk into the frame on the side *D C*. The roller could not consequently yield to the tension, or brace the slackness to which the cord-without-end is liable by the changes of the atmosphere. This cord being more or less tense, according to the degree of moisture or dryness of the air, produced continual variations in drawing the silk from the cocoons. To remedy this evil, it was necessary to make the roller cede to all the impressions of the cord-without-end; that is, to enable this roller to approach the reel when a greater tenseness in the cord-without-end drew it towards that point, and to take a greater distance whenever the cord relaxed. By these means it is certain that the cord-without-end must always be equally tense, whatever change might take place in the air.

Our author has placed his roller upon the traverse *T L*, Plate IV. This traverse is indeed fixed at the point *T*, by an iron pin, which enters easily into a hole made in the bar *D C*; but the other end *L*, only rests upon the bar *A B*, without being attached by nail or pin, so that the cord-without-end when it contracts may draw the roller nearer to the axle of the reel, and that a force

acting in a contrary direction should likewise draw it towards the little shelf when the cord slackens. That is called the moveable traverse, which contributes more than any other piece to the improvement of the winding-mill, for it supplies a remedy to all the variations of the cord-without-end.

It was not sufficient to have made this traverse capable of being moved, but it was also necessary to oppose to the cord-without-end a force that might form with it a sort of equilibrium, in order to maintain it always in the same degree of tension. This has been accomplished by the mean of a weight of six or seven pounds. This weight is suspended to a small cord that is fastened to the right side of the moveable traverse, under the roller, and that passing over the little pulley *N*, Plate IV. makes the weight fall under the winding-mill, as denoted at P.

This little pulley *N*, is set in the small bracket *N O*, which is fastened by two nails upon the bar *A B*. One may see the plan of this pulley and its bracket in the figure *r s*, Plate IV.

We may also observe the moveable traverse *T L*, in its place, furnished with its roller, with the distributing-rod and guides, and the prop *V*, which bears one end of the rod.

The figure *X Y*, represents the same traverse, seen in the same local tendency which it has

upon the mill. There are two notches 2 and 2, made in the two sides of the traverse, for the purpose of placing the prop 3 and 5. It is into the deepest groove 3 of the prop that the traverse is secured; the shallowest groove is reserved for the reception of the distributing-rod.

The piece 4 4, is a platform well glued to the traverse. Its use is to prevent the moveable traverse from overturning. This platform, as well as the traverse and the prop, is made of cedar, or pine, or of any other light wood.

Upon the traverse there is a piece of wood two inches and two tenths square, in the middle of which is the central pin of the roller. This piece of wood, and also the pin, are of walnut, and must be closely fitted and glued to the traverse. This little piece has been added to the traverse, because, having a small surface, the roller will be liable to less friction than it would have had if it bore immediately upon the traverse. The thickness of this little piece leaves a sufficient space between the roller and the traverse, to admit of a free passage to the cord that bears the weight.

At the point *c*, near the platform, a round headed nail is driven into the traverse, and the cord to which the weight is suspended is fastened to this nail. One may perceive that this cord passes over the traverse to the little pulley *N*; and this

is an additional precaution to prevent the subversion of the moveable traverse.

The figure *G H*, represents the same moveable traverse in profile. *G* 6, shows the profile of the platform; the little square piece of wood is seen at 7; the central pin of the roller at 8; the prop which supports the loose end of the distributing-rod is represented at 9, and the iron pin which enters into the bar *D C*, at the point *T*, is seen at 10.

Such is the improved winding-mill of Languedoc, which is certainly one of the most perfect machines of the kind in use at the present day. All the silk drawn from the cocoons by a mill constructed according to these rules, will be free from the disadvantage of glazing. Heretofore, the principal cause of glazing arose from the imperfect proportion between the roller and the pulley of the reel. Now, the ratio of 47 parts to 29, which the author of this corrected mill has adopted, is excellent, and the means which he has invented to maintain invariably that proportion, have finally obviated every difficulty.

1st. The substitution of iron pins is a complete remedy to that change in the proportional circumference that previously occurred by the friction of the cord-without-end, which gradually wore away the pins of wood.

2d. By placing the handle of the reel on the

side opposed to the roller, the Drawer, in presenting the threads to the Winder, is not exposed to drop water upon the roller and upon its central pin, and thus the former disadvantages resulting from that circumstance are avoided.

3d. In the ancient winding-mill there were no means of obviating the variations which the dryness and the moisture of the air produced in the two pulleys; neither were there any to amend the imperfect proportion between those two pieces when made by workmen not sufficiently scientific. A cure for both these evils is provided in the new winding-mill, by the mean of the two moveable pins which are placed or displaced according to the exigency of the case. To put one of these pins in its local position, or to take it away, suffices to change the relative proportion between the pulleys, and consequently the distribution of the threads upon the reel. If it should be perceived that the roller produce glazing, it will only be necessary to put one of the pins into the hole *t* or *u*, figure *C*, Plate IV. and the glazing will probably at once disappear. But if the distribution of the threads upon the reel should not then be satisfactoty, the other pin must be put in place.

"I do not hesitate to assure," says the author of the improvement, "that it is impossible in the three cases, that is to say, without any pin, or by the use of one or both of them, the glazing can

occur. Thus the three channels of my former roller are now advantageously superseded by the two moveable pins."

When the point which produced a good effect, by some cause of difficult exposition, comes to produce a bad one, we may resume that which previously performed badly, for a change in the first, supposes an equal alteration in the other. When the Winder perceives that her mill glazes, she places or takes away a pin, and immediately lays a piece of white paper upon the skein, sufficiently large to show the new arrangement of the thread. Without this paper, though the alteration may be enough to remove the glazing, yet the difference may be so small as to induce the Winder to believe that the change is ineffectual, she consequently makes another alteration whilst that which she abandons was doing well. A leaf of white paper must therefore of necessity be used on such occasions, in order to ascertain more readily the smallest difference of distribution, which is often sufficient for the disappearance of the glazing.

4th. All the defects of the cord-without-end are obviated by the moveable traverse, and by the weight which draws that cord with a constant equality. This cord may be made either of hemp or of cat-gut; but we prefer the latter. When it becomes necessary to take off the reel from the

mill, it must be raised with both hands from the pulley, and be suspended to the prop *Z*, of the axle, and it is then disengaged.

CHAPTER XVIII.

DESCRIPTION OF THE WINDING-MILL INVENTED BY M. DE VOCANSON.*

M. de Vocanson has also rejected the four gearing wheels which, in the Piedmontese mill,

* This gentleman, so well known in France, and to all the learned associations of Europe, is generally unknown here; it may not therefore be amiss to inform my American readers who he was. M. de Vocanson, though belonging to the privileged order, and bearing the title of Marquis, was a distinguished mechanician, an artist of mathematical precision, and a member of the Academy of Sciences at Paris. He is the only man, I believe, who has ever constructed an automaton that could audibly articulate a number of phrases. He was very laborious, and for the purpose of being roused at any desirable hour from his slumbers, he made an image in the human form, which he enclosed in a case with folding doors, and placed in his bed-chamber. When he retired to rest, he wound up the clock-work, and put the hands to the time at which he wished to rise. At the moment indicated, the figure would throw open the doors with fragor, advance to the windows, withdraw the curtains, approach the bed, perform the same operation there, and forthwith move back to its recess. Sometime after he had finished this fanciful

communicate the movement of the reel to the distributing-rod. As they are all made of wood, they are liable to many disadvantages. He has therefore re-established the use of the cord-without-end, and made the traverse, which bears the distributing-rod, moveable, with a weight of four or five pounds, that draws with an unvarying power the traverse in opposition to the cord-without-end. The pulley, the traverse and the weight always yield to the least variations of the cord; from whence it results that the guides upon the distributing-rod have always a regular movement which he proportions to that of the reel, by the difference of the diameters of the two pulleys.

This celebrated academician has judged that the ratio of twenty-two and a half for the pulley of the reel, and of the thirty-seven for the roller,

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work, a clergyman, accompanied by a military friend, made a visit to the Marquis at his estate in the country, where that machine was established. The military gentleman had never heard of the alarming night-walker, and the mischievous churchman prevailed upon his host to cede his bed to his friend, and to leave the management of the rest to him. At midnight the stranger was started from his sleep by the noisy burst of the figure into the room, and when the window curtains were withdrawn, he plainly discovered a human form advancing towards his bed. He seized one of his pistols which lay upon the night table beside him, and cried out, "stop, or I fire." The figure continued to advance, raised its arms to remove the bed-curtains, the trigger was drawn, the ball entered the body of the automaton, destroyed some of the principal movements, and it was laid aside in disgust, and, as I was informed, never repaired.

gives the most advantageous distribution of the silk upon the reel. And indeed this proportion does not bring back the threads of silk to the same points till the seventy-fourth revolution; which allows the first thread sufficient time to dry before another comes into contact with it.

In this important operation of winding the silk from the cocoons, the defect of glazing has heretofore been the plague attending the use of the cord-without-end; and this difficulty alone determined the Piedmontese to adopt the arbre and the four gearing wheels. To set absolutely at rest all future complaints, M. de Vocanson has made upon the axletree of the reel, three channels of different depths to receive the cord-without-end. When any glazing is perceived, the cord is passed from one channel to another, and by thus changing the proportion between the pulley of the axle and the roller, the previous imperfect ratio which caused the glazing is set aside. The cord is in this manner passed from one channel to another, whenever the least glazing is remarked.

Before the time of M. de Vocanson, the three channels had been tried, but they were placed upon the roller; and in that situation the cord could not be transferred from one channel to another without stopping the reel. Besides, it was necessary to give to the roller much more thickness and a proportional increase of weight.

But by transferring the three channels to the axle of the reel, one may change, as often as one pleases, the channel of the cord, without stopping the operations of the mill, and the roller, with its single channel, preserves a lightness which secures its easy rotation. The channels of the pulleys are not furnished with iron pins, because in that case the cord is so much sooner worn out. M. de Vocanson gives them the form of an acute angle, perfectly alike in the two pulleys, in order that the cord may sink equally in both, and may not be liable to slide, even when moderately stretched. "I do not fear," says he, "that the friction of the cord may disorder the diameter of the two pulleys, sufficiently to cause a sensible variation in their proportion."

This ingenious machinist has also made an alteration in the roller. Instead of fastening the distributing-rod to an iron pivot, as we see in Plates II. and IV. he makes use of a small piece of wood, one end of which is secured to the roller by a wooden screw, and the other holds the end of the distributing-rod. This piece of wood moves easily upon the screw, which serves as the centre of its motion, and the end which is connected with the distributing-rod may, at will, be removed from, or be brought nearer to the centre of the roller. M. de Vocanson, at all events, never touches it, but for the purpose of determining once for all the

width, or rather the spread of the skeins upon the reel; for he does not believe it to be requisite to vary this width from the first skein to the last.

Those different improvements made to the winding-mill give to that useful machine a great degree of perfection. To all those M. de Vocanson still adds another very important one, by the double crossing to which he subjects the threads of silk before they reach the reel. This operation greatly contributes to the beauty and to the goodness of the silk; for certainly the crossings of the two threads serve not only to press out the particles of water which rise from the caldron with the silk; to compress the different contributions of each cocoon, and to bind them together into one thread, but they serve also to render the silk neat and smooth, because the least impurities, and the loose fibres that are brought up by the threads from the cocoons, are stopped at the crossings, and when collected there in sufficient quantity, they break the threads. The Drawers dislike these accidents, because they are obliged to renew the crossings, which, without the aid of machinery, is a troublesome operation. In order to avoid these accidents, the Drawers make a small number of crossings, and then the silk reaches the reel in a less dry state, and besides, is not so sightly or so strong, because it is less compressed at the crossings, less purged of its impurities, and therefore the various

fibres of the cocoons do not adhere so well together. Moreover, it was impossible for the Drawer to make always the same number of crossings, for she was constrained to make them by rolling the two threads of silk between the thumb and finger, of which the sense of feeling is soon nearly annulled by the effect of the hot water into which she is obliged to plunge them so frequently. If she made too many crossings, the threads could not glide freely over each other; they broke, and it was necessary to begin the work anew; but if she made too few, they did not produce the good effect for which they were intended.

M. de Vocanson has removed all these difficulties in the construction of his winding-mill, by giving to the Drawer prompt and easy means of making any number of crossings, that may be prescribed to her, without even touching the threads. Besides the great facility and the extreme precision which this improved mill gives to the Drawer of making the crossings, one has the advantage of double crossings without hindering, in any manner, the threads of silk from gliding upon each other, because the great number of crossings is divided into two equal parts, with an interval of twelve inches between them. This useful invention is of the same stamp with the other productions of this illustrious man. He gives of it the following explanation.

"Between the wire-drawers and the guides, I have placed a circle of wood an inch and one-tenth wide, and little more than seven-tenths of an inch thick, whose diameter, taken from the internal border, is of six and a half inches, and equal to the distance between the two wire-drawers. This circle is placed in the middle of the breadth of the mill, and is supported by its external borders upon three rollers, fixed in a frame of wood. Upon the circumference of this circle is a groove, in which passes a cord-without-end, which encircles also another pulley of the same diameter, one extremity of whose axis is provided with a small handle, within easy reach of the right hand of the Drawer. The frame which supports the circle may be raised or lowered at will, in order to obtain a greater or less tension of its cord-without-end. Within this circle there are two ringlets of iron or of steel, set in the inner border of the circle. These ringlets are designed to receive the two threads of silk.

"When the Drawer has passed the number of fibres of cocoons, which are to compose her two threads of silk, through the two wire-drawers, the Winder, taking them forthwith from the hand of the Drawer, passes each thread through a different ringlet of the circle, then through the guides of the distributing-rod to the reel where she fastens them. Whilst she is performing this operation, the Drawer makes the crossings by simply turning

the handle of which we have just spoken. Each revolution of the handle makes two crossings, one between the wire-drawers and the circle, and the other between the circle and the guides. Consequently, twelve revolutions of the handle cross the threads twelve times before, and as many behind the circle ; and the number is increased or diminished, according to the size of the silk which one makes."

M. de Vocanson has placed, between the wire-drawers and the first crossings, an instrument which he denominates a fork, and which restrains the two threads of silk, and prevents any inequality in the position of the two crossings. Work-women who are novices in the art of silk-winding may make use of them till they become well practised in casting skilfully the threads. This fork will give them more time for the supply of cocoons to the weaker thread, which is always carried away by the stronger, and often occasions the rupture of both.

We have thus terminated our treatise upon the winding-mill by a circumstantial description of the improvements of a man celebrated for his scientific as well as for his practical knowledge in mechanics ; and unquestionably his mill gives to the silk which it produces a beauty and a quality before unknown in France. One may consult the memoirs of the Academy of

Sciences at Paris, respecting the advantages that must necessarily result from the winding-mill improved by M. de Vocanson.

CHAPTER XIX.

OF THE MANNER OF DRAWING THE SILK FROM THE COCOONS

Two persons are necessary at each mill for the purpose of conducting the operation of winding the silk. One of them is stationed at the caldron to take the management of the cocoons, and she is called the Drawer. The other charged with every thing relating to the agency of the reel, is placed near the handle of the axle, and is distinguished from her companion by the name of the Winder.

The Drawer takes care to keep the caldron full of clean water; to maintain a suitable fire in the furnace, so that the water shall be held at an equal degree of heat. It is requisite that this water be almost in a boiling state for winding off the fine quality of cocoons; that it be some degrees less hot for the demi-fine, and still less for

the satin cocoons.* The Drawer now throws into the caldron two or three handfuls of cocoons, and sinks them lightly and repeatedly in the water. For this purpose she uses a besom of the branches of the finest broom, the ends of which are split as fine as a brush, and this operation is called *beating*. The gum of the cocoons being soon liquified, the fibres of the silk adhere to the points of the besom from which the Drawer takes as many as are re-uired to form her threads; she turns them in her clears them from loose particles, cuts and tes them from all superfluous matter, and pletely purges her silk before she submits it to reel.

In the composition of her threads, she takes our, five or six fibres, and sometimes twelve or fifteen, according to the size of the silk that may be required of her, passes them through the ring-lets of the wire-drawers, to be carried by the

* My readers will here wish with me that the author had written with as much circumstantial precision as to the different degrees of heat to be given in this case, as he has with regard to the hatching process, and the treatment of the worms. But from what he has said, I think that we may reasonably conclude that the water in the caldron may be raised to 190 or 195 degrees of Farenheit, for the fine cocoons, eight or ten degrees less for the demi-fine, and as many degrees below that for the satin cocoons. Be that as it may, we have an approximation to prevent any great deviation from the points required, and experience will give us the knowledge of the best.

Winder, in two separate threads, to the reel. If the silk be drawn according to the Piedmontese method of crossing, the Drawer, after passing the two threads through the wire-drawers, crosses them from three to eight or ten times; they are then taken by the Winder, passed through the ringlets of the guides, and fastened separately upon the reel. The Winder instantly takes the handle of the axle, and turns the reel with great quickness, and the two threads of silk form two separate skeins, one at each end of the traverses of the reel.

When the silk is drawn according to the method of M. de Vocanson, the Drawer passes the threads through the wire-drawers, and gives them to the Winder, who passes them into the ringlets of the circle of wood, and through those of the guides to the reel, whilst the Drawer, by turning the little handle at her right hand, makes the number of crossings required by the size of the silk.

In proportion to the winding off of the cocoons, the Drawer is diligent in continuing to give fresh supplies to the caldron, in order that she may, by additional fibres, maintain that evenness of size which imparts value to the silk. To enable her invariably to observe this equality, she is regulated by prescribing to her two numbers, as four to five cocoons, five to six, and thus increasing to fifteen, according to the strength that we desire to give to

the threads. We call this process nourishing the silk.

To nourish skilfully the silk, the hands of the Drawer must always be ready to supply the end of the fibre of the new cocoons which she intends shall replace those that are near finishing. Before she unites these fresh cocoons to those which already compose the threads of silk, she purges them of the loose particles which served to attach them to the branches, and she then casts them dexterously with the thumb upon the threads, to which they at once adhere.

The Winder must turn the reel not only with an equal movement, but also with as much quickness as she can; for the silk will be so much the more beautiful, the more glossy, and the more abundant, as it shall remain less time in the caldron. By continuing there too long, it becomes too much soaked, and rises like a lock of wool.

The Drawer must have wood or coal and cool water within her reach; for she must keep up a sufficient fire in the furnace, and she must have a supply of cool water to pour into the caldron and upon the cocoons when the water is found to be too hot. She must also have a small bowl of cold water, into which she may dip her fingers; for without that precaution she would be unable to bear the heat of the water in the caldron. She places her besom, her bowl and the refuse cocoons

upon the little shelf in the forepart of the mill.

The water is known to be too hot when the silk is seen to rise in locks; and it is not hot enough when the silk unfolds with difficulty, which causes it to break.

The Drawer must have at hand a skimmer for the purpose of removing the worms and their skins, which settle to the bottom of the caldron after the silk is drawn from the cocoons. She must also change the water from time to time, and more especially when she perceives that it has become foul. In every case it ought to be changed two or three times a day, and we generally choose for changing it the hours in which the Drawer takes her repasts.

She ought not to cast the cocoons into the caldron before the water have attained the necessary degree of heat. If they should be thrown into the water when cool, or when partially heated, and should remain there till it arrived to a proper degree of heat, the gum of the silk would entirely dissolve, the water would penetrate and fill the cocoons, and prevent their turning; consequently the silk could not be drawn off; it would break. The same circumstances would occur if the cocoons should be cast into boiling water. Particular attention must therefore be given to this part of the operation.

As far as it may depend upon her, the Drawer

must prevent the threads from breaking. This accident is too frequent, and may generally be imputed to her carelessness or to her want of skill. When the cocoon in winding off draws towards its end, the fibre is much more slender and weak. Often four of these fibres are not equivalent to one from a cocoon just beginning to unfold. If the Drawer does not take care to nourish punctually her threads, by adding the ends of fresh fibres to strengthen them, they will break off at the crossings. She ought not to wait till one or more cocoons be finished before she joins others to her threads; for by such delay she would not only expose her threads to break, but she would make besides a very unequal and bad quality of silk.

When the Drawer neglects to purge completely the cocoons, tufts of loose silk rise with the fibres and stop at the wire Drawers, or at the crossings, and cause the rupture of the threads.

If she do not conduct skilfully the beating, so that the cocoons be on all sides well steeped, the silk will not wind off; the cocoons will rise with threads and make them break. The same accident occurs when the cocoons are not properly culled by putting the fine, the demi-fine and the satin in separate parcels.*

* It is clearly indicated by this remark, as well as by the precepts recorded in the beginning of this chapter, respecting the

The threads of silk do not resist rupture when the Drawer inadvertently throws into the caldron cocoons of which the chrysales are in a state of decay; for the putrefaction of the worm has moistened the envelope, and diluted the gum with which it had covered the internal surface. This gum formed a coat impenetrable to the ordinary impressions of air and water; prevented for a considerable time the entrance even of hot water into its cavity, consequently hindered the sinking of the cocoon, and enabled it to float and turn upon the surface of the water. When this gum has been dissolved by the putrefaction of the chrysalis, the water penetrates the cocoon, and obstructs its turning; and then if the fibre be strong enough, the cocoon rises with the silk from the caldron, and causes it to break off at the wire-drawers.

This is again the case with the cocoons that are pierced by the smallest hole; and again, also, if the Drawer be inattentive, the thread breaks when the cocoon is nearly finished; the small quantity of silk that remains around the worm comes off sometimes too easily in mass, stops at the wire-drawers, and breaks the thread.

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various degrees of heat to be given to the water, that each of these distinct species of cocoons must be thrown separately into the caldron, and that the silk must never be drawn from them together. This is one of those important rules which it is so needful to impress upon the memory of the novice, that its repetition is not only excusable, but necessary also.

The skins which the worms leave on taking the chrysalis form, and which float upon the water, are often raised with the fibres from the cocoons, and produce the same bad effects as those caused by the tufts of loose silk that are brought up from the caldron. A careful woman will use often her skimmer, and take off those floating skins, with every other impurity which may occasion that inconvenient rupture of the threads.

CHAPTER XX.

OF THE MANNER OF PREPARING THE FERRET OF FLOCK SILK.*

We call ferret, or flock silk, those coarse fibres which the worm in spinning casts about, as it were by chance, before it begins its cocoon. It may be considered as the scaffoldage, or the piles upon which it builds its house.

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* It is from this species of silk, called by the Piedmontese floretta, that the narrow riband, so well known by the name of ferret, is manufactured. I have also seen several kinds of passable cloth, and likewise stockings, made of this carded flock silk. But the price of every thing that I have seen produced from it was much inferior to the worst productions of the milled silk.

In large establishments the ferret ought not to be neglected. We collect it from the cocoons before the chrysales are stifled, and we take it carefully from about the bad cocoons, and even from those which cannot be entirely wound off, or which are not at all fit for the mill. To this inferior part of the silk we add the cocoons which were selected for seed, and were pierced by the moths; the refuse cocoons, which are previously opened longitudinally with scissors, and the dead worms, with every other impurity, taken out; and then the shells, and the ferret or flock silk, are soaked together, during three or four days, in clear water. Every day the water must be changed, in order that the silk may be sooner cleansed, and the water be preserved in a sweet state. As soon as the gum of the cocoons is dissolved, the whole becomes soft and pliable, and is forthwith put into a caldron with some clear lye, made of fine ashes, and boiled for half an hour. Afterwards it is washed in rain or river water, and when thoroughly dry, it must be carded, and spun with a common wheel, or with a spindle. If this ferret silk be carefully cleansed, well carded, and drawn to a fine thread, one may make of it stuffs of tolerable beauty, but which never have the lustre of those that are manufactured from silk drawn by means of the winding mill. The most advantageous method of disposing of this kind of silk, is

to make *houattes.** But, in order to diminish as much as we possibly can the proportion of this inferior quality of silk, we must submit the cocoons to the reel, and draw from each assorted kind all that may serve in the manufacture of fine goods, and cast into the mass of flock silk those cocoons which are fit for nothing else.

We have now brought to a close every thing that we had to say respecting the mulberry-tree, the raising of silk-worms, and the winding of the silk from the cocoons. We have added to our own method of practice, the theory and the practice of the best authors. If we have adopted the sentiments of some of them, and opposed the opinions of others, we have assigned our reasons in both cases; and we believe that we have presented the most eligible process on each of those subjects. We have taken our system of drawing the silk from the cocoons, from the most approved authors who have written on this matter, and we have extended our own reflections, because upon this operation depends the most profitable result of our labours.

* *Houatté*, or *ouate*. Under this denomination are comprised waddings, and all those shaggy kinds of silk stuffs which are used for linings, and for morning gowns in the winter season, as one of the most effectual preventives of cold. When the flock silk has been well cleansed, well carded, and spun with care, these goods are not only a guard against cold, but they are soft, and really ornamental.

APPENDIX.

The original author of the foregoing work, among a variety of excellent precepts for the raising of silk-worms, has prescribed the degrees of heat most conducive to the health of the brood in its different ages, and has most properly adopted a mean temperature for bringing the worms to the spinning state in about forty-two days after issuing from the eggs. But these are not the only benefits resulting from that prescription, for I think that the quality of the silk is also improved by the maintenance of a proper temperature, and I will here present to my readers the ground of this opinion.

In the environs of Canton, and probably in many of the southern parts of China, a great deal of silk is gathered from the mulberry-trees, where it is spun by the worms, exposed to all the changes of the atmosphere. This silk is of a coarser fibre than that which is spun by worms produced and fed under cover, and it is sold also at a diminished price. I hold this information from an intelligent relation of mine, M. Olyphant who had resided about three years at Canton. Now, as the quality of the silk is improved by causing it to be produced under shelter, the degrees of warmth maintained there must likewise have some influence upon its properties. The usual difference that we can, by conjecture, assign to the temperature of the air at noon and at midnight, in the country about Canton, must amount to eight

or ten degrees, and sometimes it doubtless exceeds twenty. In our southern States, therefore, the early appearance of the leaf, as well as the early warmth of the climate, may admit of the existence of the silk-worm upon the tree, yet there it would be adviseable to erect buildings to shelter the worms, for there the changes of temperature are greater, are more sudden, and more frequent than at Canton.

I now hasten to the subject which I had in view when I ventured to exhibit this short Appendix. The production of silk has become an object of great interest, not only to the General Government of the United States, but also to the British Nation. A company has lately been incorporated there, under the title of the British, Irish and Colonial Silk Company. Several members of the Administration, many noblemen and individuals of distinguished rank and influence, have given support to this Institution, by placing their names on the list of subscribers. "Twenty thousand shares were issued in the month of October, 1826, at fifty pounds sterling each, for the purpose of raising a capital of one million sterling, to be invested in land, and other objects connected with the undertaking. A general meeting of this Company was convened on the first of May, 1827, and Lord Auckland was voted into the Chair. The objects of the inquiries of the Board of Directors, as reported by them to the meeting, were—

"1st. The growth of silk in Ireland.

"2d. The growth of silk in England.

"3d. The growth of silk in those Colonies which promise the greatest advantages for the cultivation of silk.

"On about eighty acres of land in Ireland, three hundred and eighty-eight thousand trees, or plants, of the white mulberry have been set, and a gardener had been despatched to superintend their management and cultivation.

"On nineteen acres at Slough, in England, upwards of seventy-four thousand trees and plants were then in a flourishing state.

"At Malta, where the mulberry-tree attains to a great size, the Agent of the Company had already introduced from Italy one hundred and ten thousand plants of the white mulberry, in

addition to forty thousand trees, or plants, ceded to the Company by the Government."

At the same time that this active Company was pursuing with so much zeal the scheme of these large establishments of mulberry trees, it had despatched an Agent to the south of France and to Italy, to procure the best information upon this branch of cultivation, and to secure a channel for the purchase and conveyance of plants and seed of the mulberry, and the eggs of the worm. This Company and its Agents have not been idle; but let us look for the cause and the grounds of all these exertions. We shall find them both in the large importations of raw silk, and in its constant demand, for the supply of the extensive silk manufactories of that kingdom.

"From the fifth of January, 1823, to the fifth of January, 1824, the raw silk imported into Great Britain amounted to 2,462,130 pounds, of which 1,611,378 pounds were from Bengal, China, and Persia; 196,787 pounds from Italy, and the remainder from France, Turkey, and other parts of Europe. The amount of organsine silk imported within the same period was 359,641 pounds, all from Italy, with the exception of a single pound from France. The imports of raw silk during the year ending on the 5th of January, 1825, amounted to 3,382,357 pounds, of which 1,713,724 pounds were furnished by Italy, and 1,307,300 pounds were supplied by the East Indies and China, and the rest from various places.

"Mr. Wilson, a well informed silk manufacturer, estimates the number of looms employed in the manufacture of silk at 40,000, and including weavers, warpers, machinists, harness-makers, enterers, twisters, cane-spreaders, quill-winders, and draw-boys, at two hands to a loom, will employ 80,000 persons, and their aggregate wages will amount to 3,000,000 sterling—(13,333,332 dollars.)

"If we include infants and dependants, about four hundred thousand mouths will be fed by the silk manufacture in England, the value of which he estimates at 10,000,000 sterling."—(44,444,444 dollars.) We see here reasons enough to draw the attention of their Government, and of enlightened individuals, to the production of the raw material upon their own territories.

British organsine silk pays a duty of only 8d. a pound on the raw material from which it is prepared. But for all the richer goods, such as damasks, satins, gauzes, &c. in which the French are their great rivals, Italian organsine silk is still indispensable. From this circumstance it is presumable that the British artists are not well versed in the science of making this superior quality of silk, or that the raw material which they import and convert into organsine, has not been drawn from the cocoons by a proper mill, or with sufficient care to prevent the glazing. Many years ago, a patent was granted, for fourteen years, to Sir Thomas Lambe and his brother, for the exclusive establishment of the famous silk mill established by them at Derby, from models which they had *clandestinely obtained* in Italy, for preparing organsine.

At the expiration of the time, the British Parliament refused a renewal of the patent, but (with that honorable sense of justice towards the citizen, which has always distinguished that legislative body) "it voted to the two brothers a recompense of fourteen thousand pounds, in consideration of the services which they had rendered to the country, by erecting a machine which it was supposed would relieve the nation from the expense of importing organsine from Italy." Yet, as it appears by the importations so late as 1824 and 1825, they are still dependant upon the Piedmontese for this material of their best silk goods.

These facts have been extracted and consigned here, for the purpose of contributing to diffuse among my fellow citizens the knowledge of the immense importance of the subject, and of exhibiting to them one of the great results of the vigilance of the British Administration, always awake to the momentous interests of the nation, and always ready to make temporary sacrifices for the production of permanent benefits.

After leading my readers on that little excursion to Great Britain, which I hope they will not find wholly uninteresting, I will now conduct them back to the land of their affections, and perhaps a little more fully impressed with the magnitude of a subject, which in all the preceding pages, I have endeavoured to present clearly, if not forcibly to their notice. In order to stimulate their enterprise at home, and to show the benefits which will

accrue to themselves, as well as to their country, from the cultivation of mulberry-trees and the raising of silk-worms, I have deduced from some of the pages of this work the subsequent condensed statement, by which the profits resulting from the undertaking may be at once seen.

Sixteen rods, two hundred and sixty-four feet in length, and ten rods, one hundred and sixty-five feet in bredth are a statute acre, and will contain six rows of mulberry-trees, if the rows be made twenty-five feet apart. But the trees must be set at the distance of thirty feet in the rows, and when placed in the quincunx form, the diagonal line from a tree in any one of the rows to the nearest tree in the next row, will be about thirty feet. According to this arrangement, there will be eight trees in each row, and the acre will support forty-eight trees. Now it is related in one of the preceding pages, that a full grown white mulberry-tree under proper cultivation will yield three hundred pounds of leaves. But I will assume only two hundred pounds as the average produce of each tree in this plantation, which at one dollar per quintal will give ninety-six dollars of yearly income for a single acre of land: for I presume that the fruit of these trees, used as food for poultry and sheep, will nearly compensate the proprietor for the expense of cultivation. Such a result would alone be a sufficient inducement to plant the trees; but if, like a provident husbandman who reserves his fodder for his own cattle, he gather and deal out these leaves to his own silk-worms, the great profit arising from the enterprise is yet to be told.

Allowing then the reduced quantity of 200 pounds of leaves to each tree, the forty-eight trees will give 9600 pounds, furnishing a supply of food for 384,000 worms, substituting 1000 pounds instead of 900 pounds of leaves, mentioned by my author, to bring to maturity 40,000 worms. Taking the ratio of 3000 worms to a pound of silk, though I have some reason to think the estimate too low, but according to that, the 384,000 worms will yield 128 pounds of silk.

One hundred twenty-eight pounds of silk, at the low price of $4, will produce $512—Deduct for wages and contingent expenses $125—for winding the silk from the cocoons, $125—and

there will remain, $262—which may be considered as the produceof a single acre of land, with as much propriety as the amount of money received for cattle, sold from a farm of pasturage land, may be reckoned as a part of its rents.

Vegetation is here more rapid and more luxuriant than it is in the southern parts of France, because there is here a greater combination of moisture and heat. The assumption, therefore, of two hundred pounds of leaves from a full grown white mulberry-tree is extremely moderate, since, in the dry climate of Provence, these trees are known to produce, when under good cultivation, an average of 300 pounds of leaves. Now, if it be conceded that I have made a generous allowance for wages, contingent expenses, and the operations of the mill, the premium of $262 per acre is the encouragement held forth to the diligent Cultivator.

I have now brought to its conclusion a work which required some critical attention to the distribution of the materials, in order that every part of the Treatise might be distinctly presented to the mind of the reader. If it should tend to advance the production of silk in the United States, and to induce our cultivators to adopt a better system in the general management of their fruit trees; and above all, if any thing contained in it should ever give bread to one who might otherwise have needed it, I shall not have laboured in vain. The production of silk is one of those great objects of national industry, which the variety of our soil and climate, under the fostering hand of a wise Government, will render of easy introduction. There are many others which claim the encouragement and the protection of the General Administration, without which this nation must, in some respects, long remain stationary. Even now the hand of Providence points, with unerring constancy, to our vast extent of hills and slopes, which invite the vine; and I may venture to assert, that if the destructive use of distilled spirits, which continues to make such ravages throughout the Union, should not, within a few years, be discontinued by the substitution of a wholesome wine from our own soil, it will be the fault of a negligent, or a too parsimonious legislation. The people of civilized countries see, and sensibly feel, and warmly applaud, every act of their

Government that tends to promote the general prosperity and happiness of the nation. It is this public and acute feeling which has continued to this day, in the French nation, the love and the respect which it bears to the memory of Louis XII. and Henry IV. Does it not, then, from thence appear to be a leading truth in legislation, that the applause, and the permanent affection of a people, can be obtained only by decrees productive of a lasting public good, and by measures which, for a long time to come, will give employment and bread to the labouring poor, and fill the country with such resources as will enable it to rely upon its own strength? What though it be difficult in a Legislature, composed like ours of members from various independent States, for a man to divest himself of his local predilections, and resolve to be guided by a lofty feeling for the general interest and improvement of the whole Republic; yet, notwithstanding this impediment to our course, we may look forward with pride to the high destinies of our country, when every desirable production of the earth shall be found within our own borders; when all the science of modern Europe, and the perfection of the fine arts which immortalized ancient Greece, fostered by a liberal Government, shall flourish here; when this great Republic shall be connected and bound together by a chain of rail-ways and canals, and the vast commerce of the Mexican Gulf shall pass through our Florida Territory, and the flag of this Union, protected by the vigilance and the established character of our gallant navy, shall float unmolested in every quarter of the world.

ADDITIONAL NOTE.

This treatise was terminated in the autumn of 1827, and offered to the press in the month of February 1828, with the intention of having it published before the rising of the last session of Congress. It would be useless to detail here, the reasons of the delay, attending its complete impression, till August. But in the mean time, a meritorious work on the subject of silk-

worms has made its appearance under the sanction of the Legislature of the United States. Although that closely printed volume of 220 pages contain, in a condensed form, a mass of information with regard to the production of silk, and to the machinery for the manufacture of silk stuffs, yet may I hope that some additional knowledge is comprised in this work which treats so thoroughly on the cultivation of the mulberry tree, and on the dangers of glazing, a defect which disqualifies the silk for all the purposes of the most valuable kinds of goods. The precepts relating to the care of the silk-worm are nearly the same in both works. M. de la Brousse, however, recommends a hatching process a little different from that of Dandolo, and has adopted a gradation of heat somewhat higher; and consequently the worms appear in considerable numbers on the seventh day, and the hatching terminates on the tenth day; but the few that make their appearance before the seventh and after the tenth days are thrown away. The lower temperature of Dandolo requires twelve days for the close of the operation.

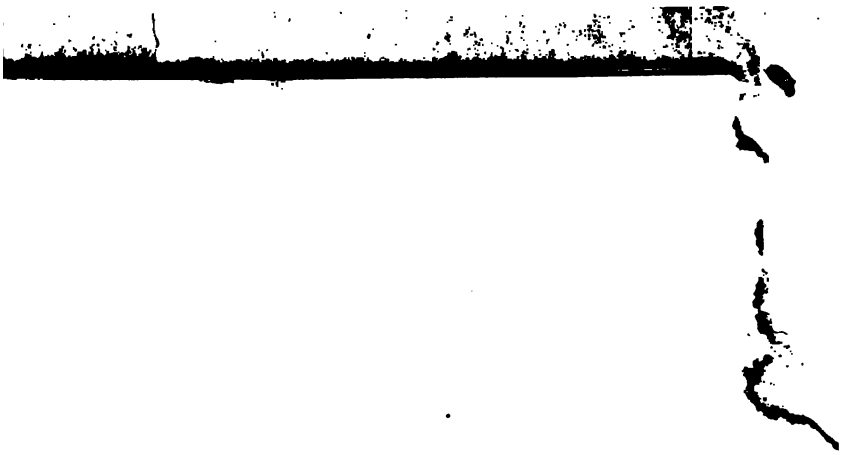
My author also mentions the covering of the eggs, when hatched in boxes, with white paper pierced full of little holes, through which the worms climb in search of food. But I acknowledge that I do not see the necessity of the boxes and pierced paper. A plain table, covered with clean white paper, upon which each ounce of eggs is separately spread with mulberry leaves at easy reach, is more simple, and as it appears to me, all that is necessary. In the state of nature, these worms, from the instant of their birth, are surrounded with mulberry leaves, and to them they quickly cling without the embarrassment of seeking a passage through perforated paper. As for the rest, if the two methods should be simultaneously tried, and the results should be found equal, that which can be practised with the least trouble and the least expense will always be preferred.

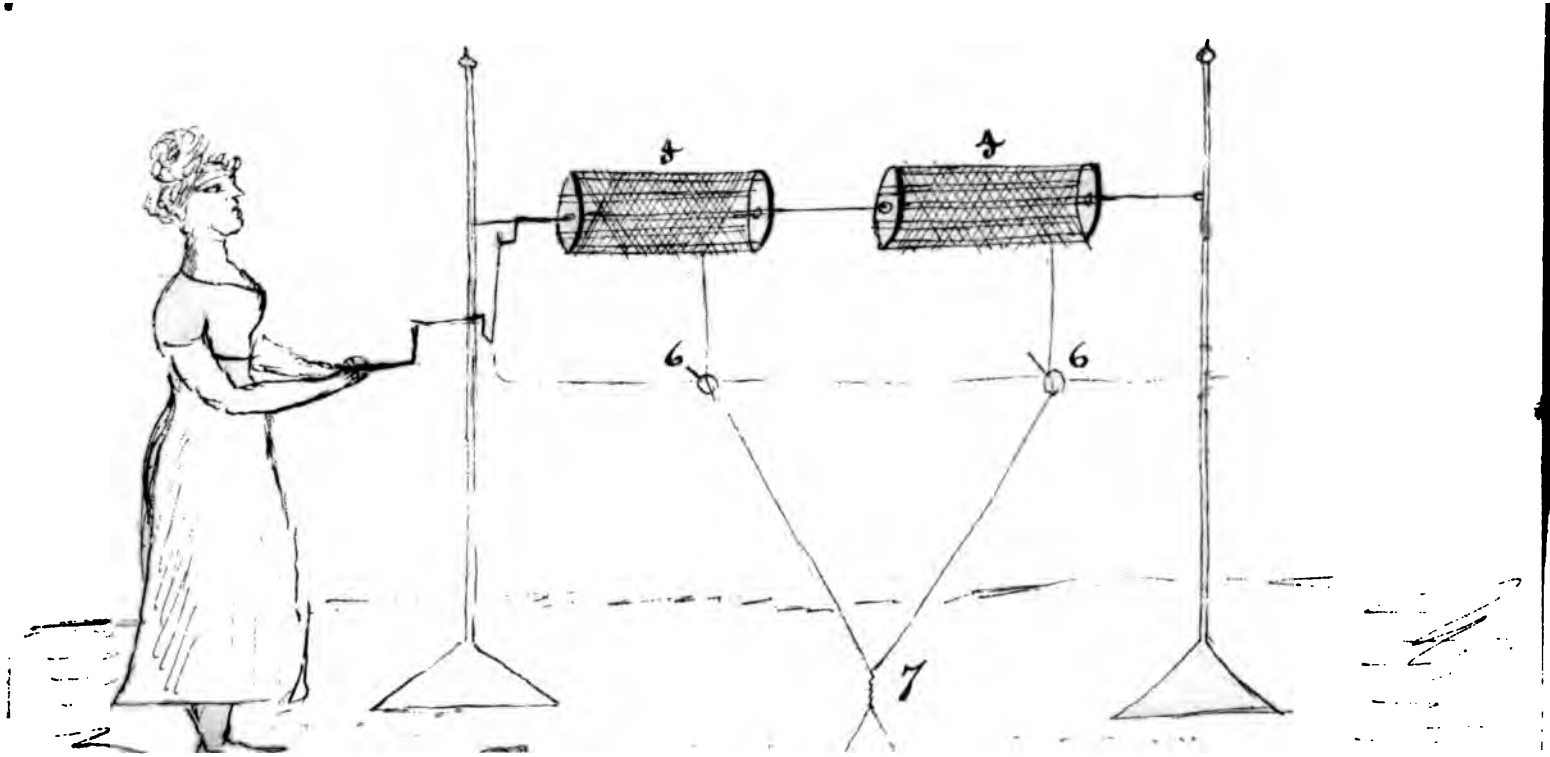
The learned and sagacious compiler of the above mentioned manual, very properly condemns all those fumigations with aromatic herbs and burnt vinegar, heretofore recommended by most authors on the subject of silk-worms, and he even doubts of the utility of the fumigating bottle, except for very large establishments. This purifying fumigation, invented, I believe, by

Guyton Morveau, and now generally used in the hospitals of Europe, is prepared and applied in the following manner: Take six ounces of common salt, mix it well with three ounces of the powder of black oxide of manganese, put this mixture in a strong bottle, with two ounces of water, and cork it well with a common cork; keep this bottle in a part of the room farthest from the stove or fire places. In another bottle, or large phial, put a pound and a half of sulphuric acid, (oil of vitriol,) and keep this phial near the bottle containing the mixture, as also a small cordial glass, and an iron spoon. This is the manner of using it: Put into the small glass two-thirds of a spoonful of the oil of vitriol, pour it into the bottle of mixture, and there will issue a white vapour. The bottle must be moved about through the room, holding it up, that the vapour may be well spread in the air. When the vapour ceases, the bottle should be corked and replaced. During the fifth age of the worms, it is good, according to Dandolo, to repeat this fumigation three or four times a day. When repeating the fumigation, the quantity of the oil of vitriol poured into the bottle may be diminished. The stated quantity of ingredients will be sufficient for the produce of five ounces of eggs. "This remedy may be employed, whenever, in going into the room, the air has an unpleasant effluvia, and that there is any closeness or difficulty of breathing. It may also be applied when the litter of the silk-worms is removed. It must be observed that care should be taken not to drop any of the oil of vitriol on the skin or clothes, and to hold the bottle above the height of the nose and eyes when it is open, because the vapour is very searching, and would be dangerous as well as unpleasant. Should the substances in the bottle harden, a little water may be added, and stirred with a stick. This easy remedy, says Dandolo, is more powerful than all the perfumes commonly used, and produces five advantages. 1st. The vapour, in spreading, immediately destroys any unpleasant effluvia. 2d. It diminishes the fermentation of the litter, and dries it up. 3d. It neutralizes the effect of all the miasmata, and deleterious emanations that might attack the health of the silk-worms. 4th. It revives the silk-worms, gently stimulating them, because it is composed, in a great measure, of pure vital air. 5th. The vapour is not

alone favourable to the health of the silk-worm, but influences the goodness of the cocoon."

These are very important results, and presented by a man of his practical knowledge, no one can believe them to be altogether imaginary. If there should be any doubt of the beneficial effects of this fumigation, it would be easy to determine that doubt by placing silk-worms of the same brood in different rooms, and using the fumigations in one of them, and none in the other. In small establishments, however, nothing more is requisite than a frequent change of air, with due attention to a proper temperature, regularity in feeding, cleanliness, and above all sufficient space. Crowded enclosures cause diseases and death among a brood of silk-worms; and my author, a man of twenty years experience in this business, will allow only one hundred to one hundred and ten worms in the fifth age to occupy each square foot.

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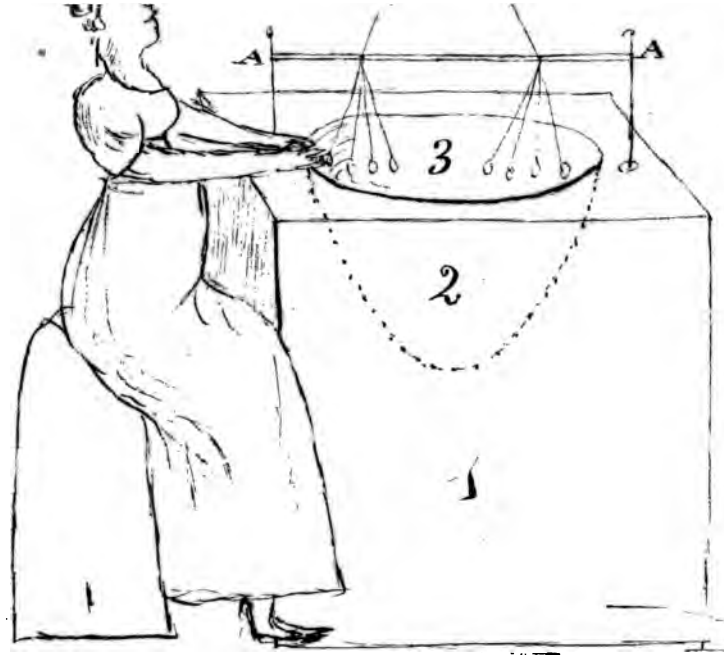
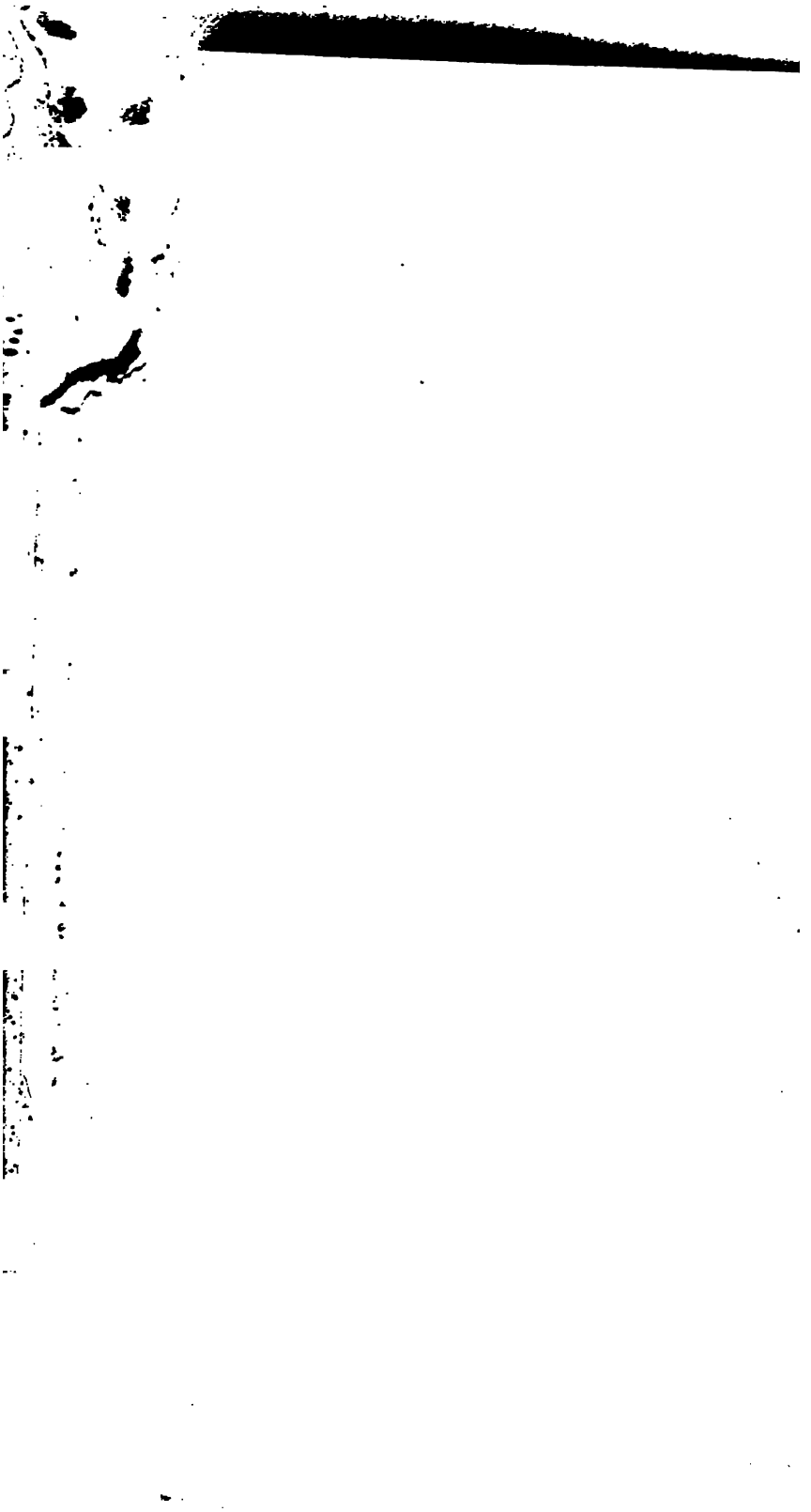
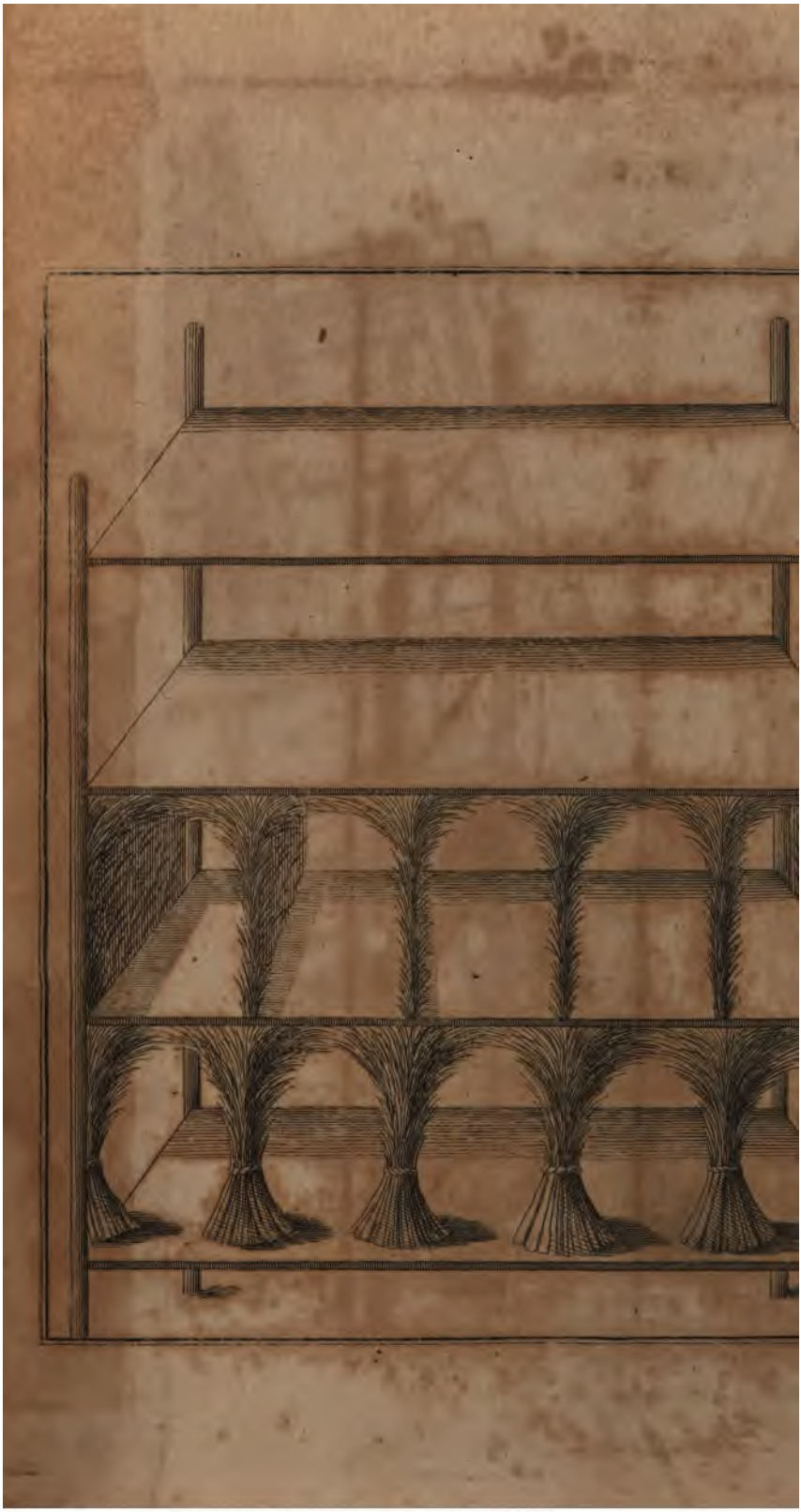


1 Stove
2 Small shallow Copper pan about 2 feet by 18 inch.
3 Cocoons in hot Water
AA Iron bar across and a few inches above the water with 2 small holes thro'g.





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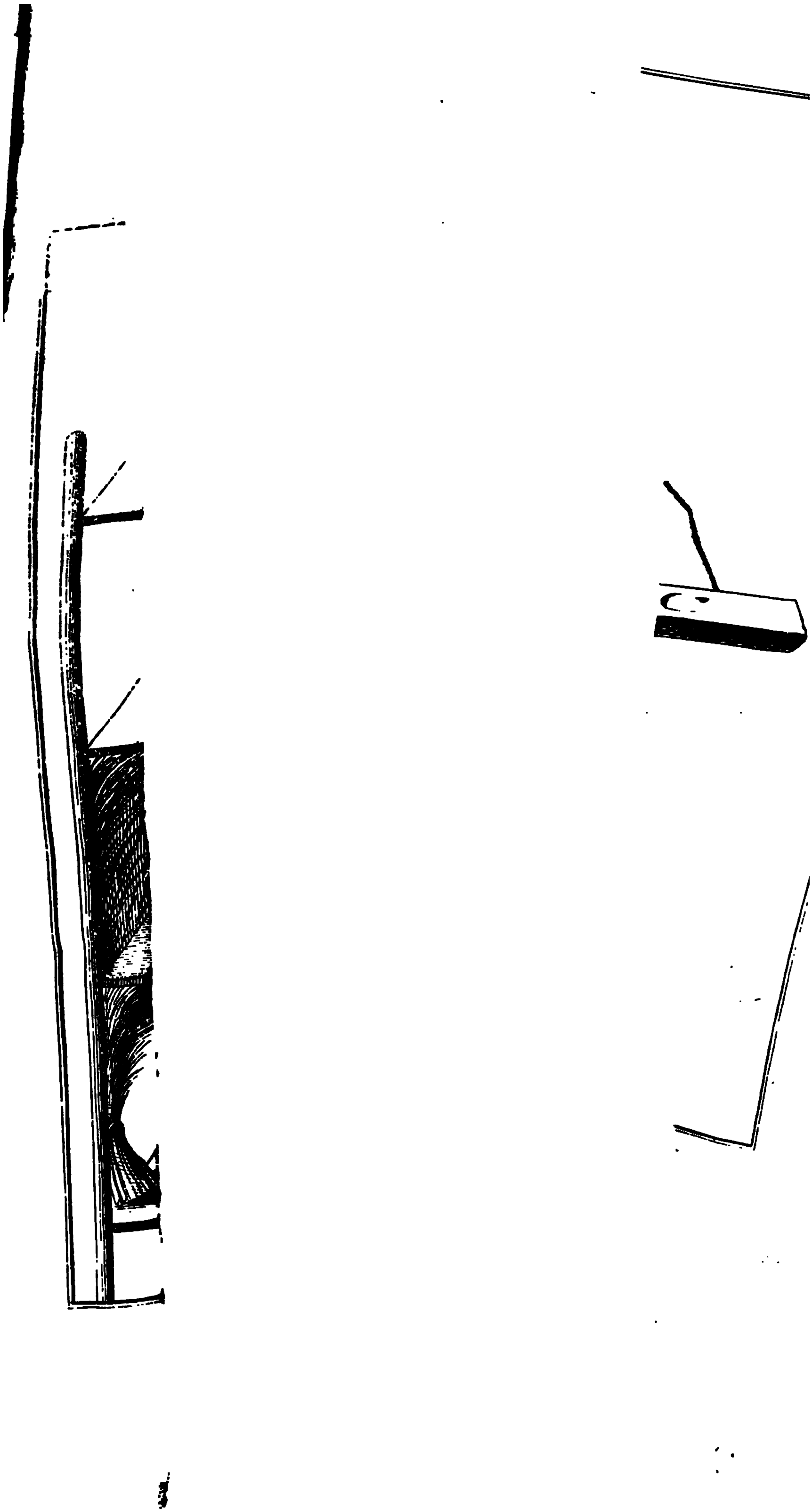

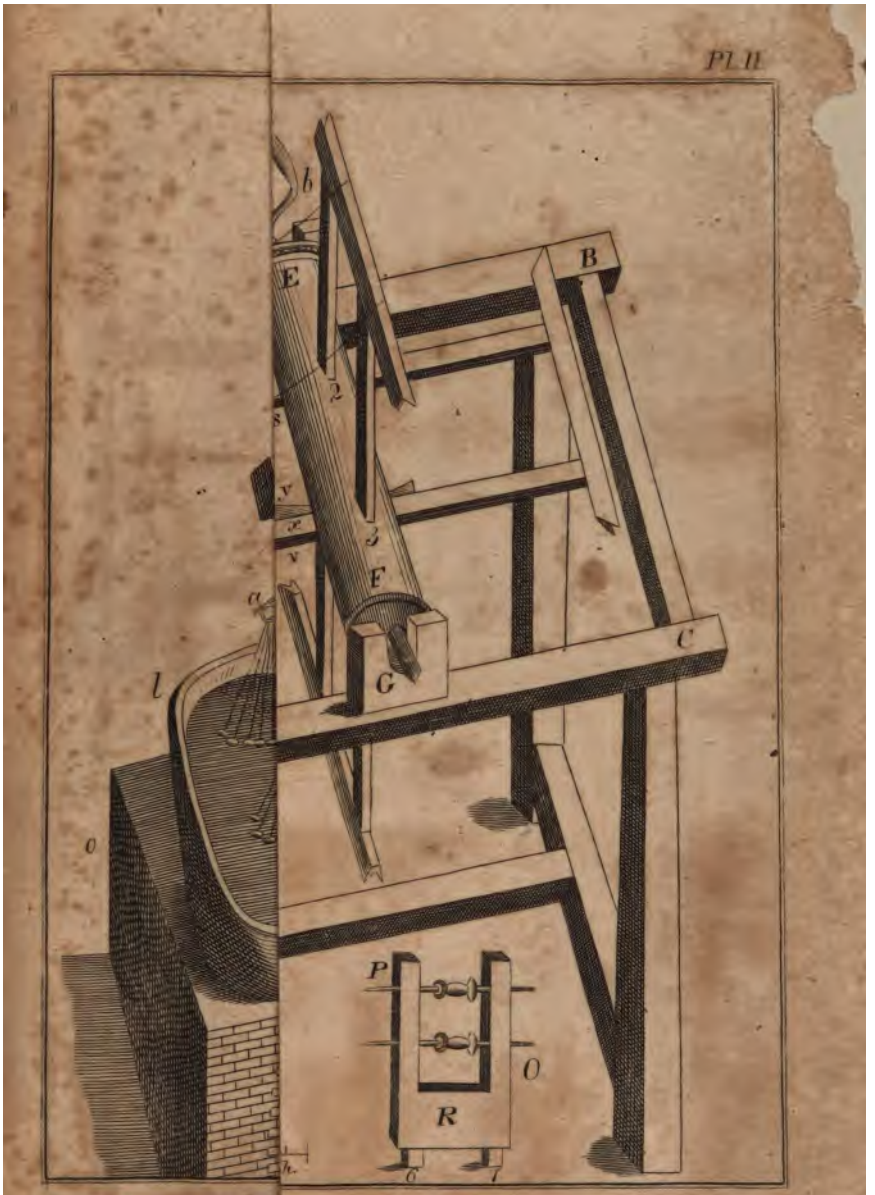
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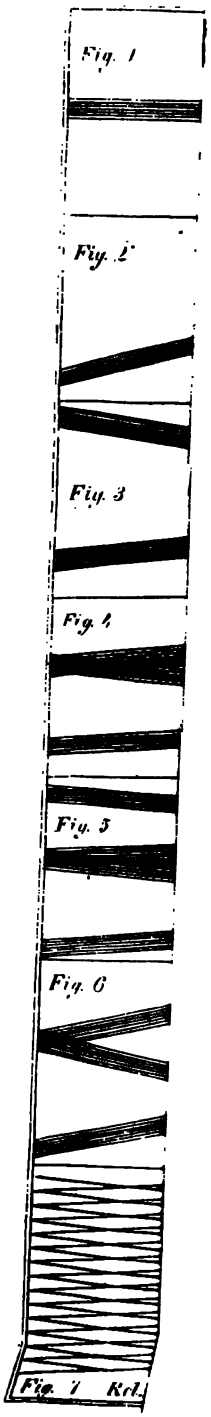
Fig. 1
Fig. 2
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Fig. 6
Fig. 7 Rel